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Physics. — *On the construction of platinum thermometers and the determination of their basic points.* By W. H. KEESOM and B. G. DAMMERS. (Abstract of Communication N⁰. 239*d* from the KAMERLINGH ONNES Laboratory at Leiden).

(Communicated at the meeting of October 26, 1935).

In 1927 the 7th General Conference of Weights and Measures decided to fix a temperature scale, called the "International Temperature Scale", which for temperatures from —190° C to 660° C depends on readings of the platinum thermometer. As a result of an analysis of the experimental basis on which the definition of the international temperature scale rests, the KAMERLINGH ONNES laboratory decided not to accept that scale. So the Leiden Laboratory continued to compare its platinum thermometers directly with the helium thermometer.

At the same time we decided to construct from wires of different origin a number of platinum thermometers which satisfy the exigencies mentioned in the definition of the international temperature scale, and to compare them from 0 to —183° C with the helium thermometer. This paper contains the details of construction and measurement of the basic points.

The optimum annealing temperature lies at 840 to 850° C.

The oxygen point was taken at -182.98^{3}° C, derived as an average of previous Leiden determinations recalculated with recent values of the fundamental pressure coefficient and of the second virial coefficients of helium. A new determination gave -182.98^{5}° C.

The accuracy of the calibration of the platinum thermometer at the ice-, steam- and oxygen-points appears to be about 0.002 to 0.003 degree.

Physics. — *Comparison of some platinum thermometers with the helium thermometer between* 0 *and* —183° C. By W. H. KEESOM and B. G. DAMMERS. (Abstract of Communication N^{0}. 239*e* from the KAMERLINGH ONNES Laboratory at Leiden).

(Communicated at the meeting of October 26, 1935).

Five platinum thermometers, which satisfy the conditions stipulated in the definition of the international temperature scale, were compared with the helium thermometer between 0° C and —183° C in a cryostat giving a temperature constant and uniform within 0.002 degree.

The readings of three of the thermometers (two of wire from HERAEUS, one of wire we obtained from the Bureau of Standards) agree within 0.003 degree. The fourth thermometer, made from wire furnished by JOHNSON and MATTHEY and not directly compared with the others, agrees with those mentioned within the accuracy of the readings of the helium thermometer.

The fifth thermometer, from HERAEUS wire, gives readings which differ 0.03 degree at —138° C from those of the first mentioned set.

The international temperature scale lies for temperatures between 0° C and —100° C below the thermodynamic scale to an amount of about 0.04 degree at —80° C.

Between —120 and —183° C the international temperature scale lies above the thermodynamic scale. Maximum deviation between —130 and —140° C. Amount of the deviation as shown by the four first mentioned thermometers 0.01 to 0.02 degree.

Physics. — *The Isotopic Constitution of Iron.* By J. DE GIER and P. ZEEMAN.

(Communicated at the meeting of October 26, 1935).

Looking at an isotopic table of 1934, one will perceive that iron as well as nickel are still tabulated with two isotopes. Titanium and chromium, the two elements of even atomic number that immediately precede have five respectively four isotopes. And the following elements such as zinc and germanium are known to consist of five isotopes each.

Such a point of view made it already apparent that more isotopes of nickel and iron will exist. The difference could easily be explained by the experimental difficulties in examining these substances.

Attempts to systematize the isotopic table, such as MATTAUCH's ¹) rules, consequently predicted several isotopes in this region as well.

Meanwhile the isotopic constitution of nickel has been settled, four even numbered isotopes ²) being identified.

Iron now examined by us, was early dealt with by ASTON ³) by means of volatile carbonyl. He reported on two isotopes of mass numbers 56 and 54 with an estimated abundance of 95 % and 5 %.

Recently ⁴), in using a particularly pure sample of the carbonyl, ASTON discovered a third isotope of mass number 57. The values obtained for the relative abundance were:

Mass numbers	54	56	57.
% abundance	6.5	90.7	2.8.

A line of mass number 58 was also present but weakened as the work proceeded and was, according to ASTON, most probably due to traces of nickel still left in the tube from the preceding nickel experiments.

Already during the summer we made experiments with iron. The carbonyl was used, but as we had only the disposal of a sample dissolved in paraffin, the experiments were not conclusive.

Exposures with intensities sufficient to obtain all three isotopes were taken. Lines for the monocarbonyls of these isotopes were equally present as well as several higher carbonyls from the strongest isotope.

But nevertheless line 58, though always present, could not be identified with sufficient certainty.

The cause was that the solvent had too high a vapour pressure. The carbonyl got greatly contaminated by the vapour of the paraffin. So the photos exhibited strong series of carbonhydrides, which series often reached beyond the iron group.

This was demonstrated by the frequent presence of 55 and by the enhanced intensity of 57 and 58.

At the same time much hydrogen was liberated in the tube by the action of the discharge, and the formation of ironhydride could not always be excluded.

A generous gift of the I. G. Farbenindustrie at Frankfurt helped us out of this trouble. A free sample of very pure carbonyl was sent to us, for which we are highly grateful.

Yet it was by no means easy to obtain photos with sufficient intensity. The discharge with the pure sample was much more difficult to manage than in the case of nickelcarbonyl. To keep the tube steady, it required diluting with much oxygen. While nickel gave a black deposit all over the

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¹) J. MATTAUCH, Zeitschr. f. Phys., **91**, 361, 1934.

²) J. DE GIER and P. ZEEMAN, These Proceedings, page 810.

³) F. W. ASTON, Phil. Mag., **45**, 940, 1923. Ibid. **49**, 1198, 1925.

⁴) F. W. ASTON, Proc. Roy. Soc. London, **149**, 402, 1935.

J. DE GIER AND P. ZEEMAN: THE ISOTOPIC CONSTITUTION OF IRON.

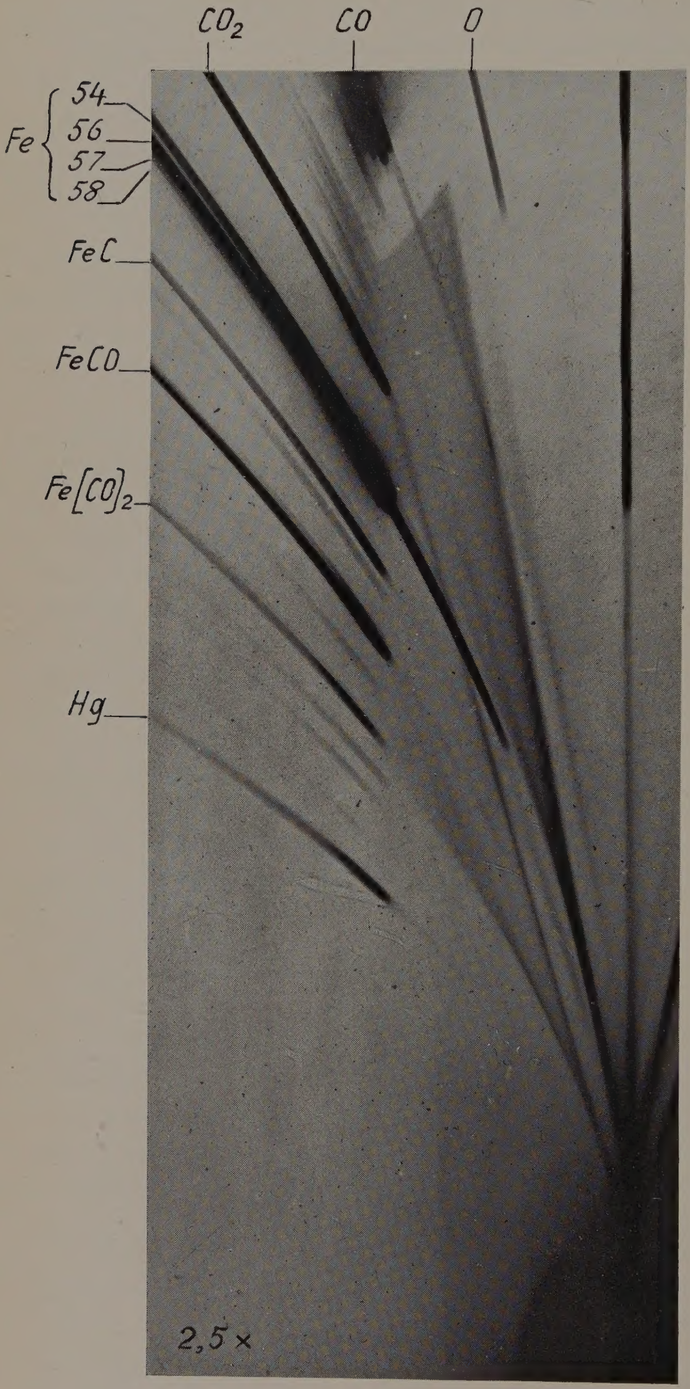

Fig. 1.

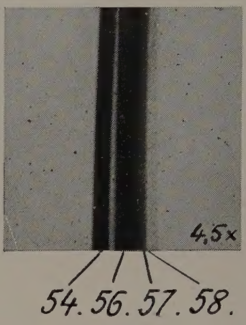

Fig. 2.

wall of the heated tube, iron by the action of the discharge mainly deposited in the cathodic region, causing a quick disturbance of the bundle.

On the other side too much oxygen soon reduced the iron intensity. The more so as the carbonyl contains five CO groups the concerning line being by far the most intensive one.

Added to this it was difficult to keep the discharge conditions constant for a long time.

With properly chosen canals the intensity of the iron lines could be increased so far that isotope 58 can be seen in the reproduction (fig. 1 and 2). The photo — taken with the pure sample — could easily be interpreted now. Iron hydrides were not feared further and all compounds in this region have disappeared.

The appearance of line 58 could now be followed closely when varying the circumstances of the experiments. In this way we obtained several most convincing plates of the new isotope.

The abundance relative to 57 was estimated by varying the time of exposure. On account of the wide canals however the resolving power of the apparatus is only just great enough to separate 56 and 57. The shadow of the principal isotope made it difficult to give a figure. But surely we will not be far from the correct value if we take the abundance of 58 relative to 57 at 1 : 6. With this figure the table runs as follows:

Mass numbers	54	56	57	58
% abundance	6.5	90.2	2.8	0.5

Laboratory „Physica" of the University of Amsterdam.

Oct. 1935.

Physics. — *On the dissociation energy of* CO. By D. COSTER and F. BRONS.

(Communicated at the meeting of October 26, 1935).

Figure 1 gives the level diagram of the CO-molecule at which we arrived in our recent investigations. The position of the dissociation states relative to the electronic levels is based upon the observation of predissociation phenomena in the CO-bands. Formerly [1]) we already observed predissociation in the upper level ($B^1\Sigma$) of the ÅNGSTRÖM-bands at 11.08 volts above the normal state of the molecule. At first we interpreted this predissociation as due to the dissociation state $^3P + {}^1D$ and arrived in this manner at a dissociation energy of the normal level ($X^1\Sigma$) of 9.82 volts. Later on we revised this view and ascribed the predissociation in $B^1\Sigma$

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[1]) D. COSTER and F. BRONS, Physica 1, 155, 1934.

to the dissociation state $^3P + {^1S}$, which gives 8.41 volts [1]) for the dissociation energy of the normal state. This interpretation, which is also given in

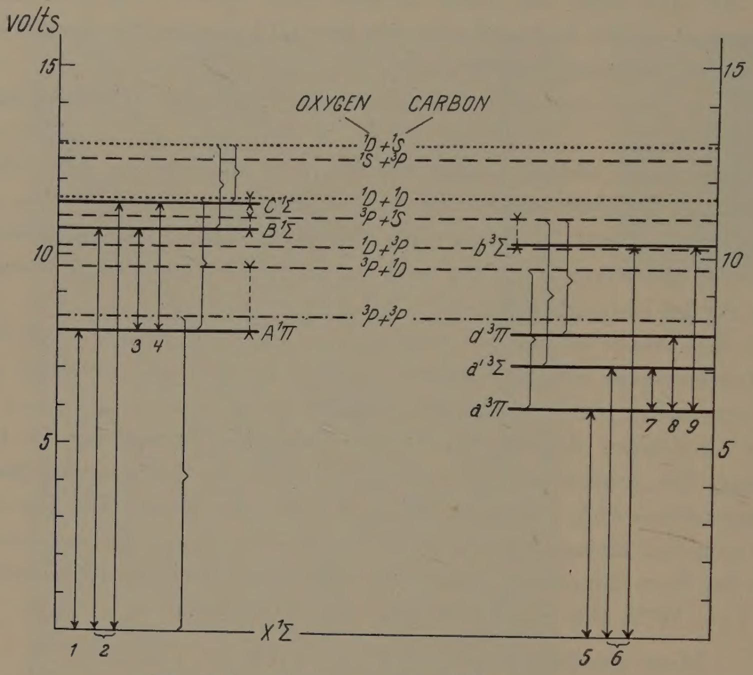

Fig. 1. Level diagram of the CO-molecule.

The singlet levels are the horizontal fully drawn lines to the left, the triplet levels those to the right of the figure. The dotted and dashed horizontal lines are the energy states of the molecule dissociated into different excited atoms. (^3P (oxygen) + ^3P (carbon) give rise to singlet, triplet and quintet molecular levels; $^3P + {^1D}$, $^1D + {^3P}$; $^3P + {^1S}$ and $^1S + {^3P}$ only to triplet levels, $^1D + {^1D}$ and $^1D + {^1S}$ only to singlet levels). The brackets join the molecular levels with the atomic states into which they respectively dissociate. The vertical dotted lines join the molecular levels with the dissociation states which cause predissociation in them. The vertical arrows give the observed possible transitions; they are:

1 fourth positive carbon group
2 absorption bands of HOPFIELD-BIRGE
3 ANGSTRÖM-bands
4 HERZBERG-bands
5 CAMERON-bands
6 absorption bands of HOPFIELD-BIRGE
7 ASUNDI-bands
8 so-called triplet-bands
9 third positive carbon group.

figure 1, is in better agreement with the value of the dissociation energy of the $A^1\Pi$-level found by extrapolation of the vibrational formula for the fourth positive group. Still the dissociation energy of CO remained uncertain. The question would be settled if it were possible to find a predissociation in one of the CO-bands caused by another dissociation state. This was tried by SCHMID and GERÖ [2]). They found a sudden decrease in intensity of the HERZBERG-band-lines, which they interpreted as due to a predissociation in the upper level $C^1\Sigma$ at a height of 0.48 volts above the level which causes predissociation in the $B^1\Sigma$-level of the ÅNGSTRÖM-bands. They compared this energy difference with the energy difference of the atomic states: ^1D (oxygen) + ^1D (carbon) and ^3P (oxygen) + ^1S (carbon), which amounts to 0.54 volts, and came in this way also to a dissociation energy of the normal CO-molecule of 8.41 volts. The difference between the measured value of 0.48 volts, however, and that given by their interpretation of the dissociation states (0.54 volts) seems rather large: indeed the value ^1D (oxygen) + ^1S (carbon) — ^1S (oxygen) + ^3P (carbon) = 0.46 volts would fit better with the measured value. This would give a much lower dissociation energy, viz. 6.90 volts. For this reason it seemed to us that by the work of SCHMID and GERÖ the question is not finally settled.

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[1]) D. COSTER and F. BRONS, Physica **1**, 634, 1934.

[2]) R. SCHMID and L. GERÖ, Zs. f. Phys. **96**, 546. 1935.

During the course of an investigation of the rotational structure of the fourth positive group one of us (F. BRONS) found a sudden disappearance of the lines which combine with the vibrational level $v' = 10$ of the upper level $A^1\Pi$. This place was found to be 9.67 volts above the $X^1\Sigma$ ($v = 0$, $J = 0$)-state of the molecule, thus giving a difference of $11.08 - 9.67 = 1.41$ volts with the energy of predissociation in the ÅNGSTRÖM-bands. This energy difference exactly agrees with the energy difference between the states of the carbon atom ^1S—^1D (= 1.41 volts). By this beautiful agreement the level diagram of figure 1 is definitely proved to be the right one; it gives 8.41 volts for the dissociation energy of CO, or 193.9 kcal per mol.[1]. For the other molecular states we find the dissociation energies of table 1.

TABLE 1.
Dissociation energies.

Molecular state	Dissociation into:	Energy of dissociation
$X\ ^1\Sigma$	^3P (0) + ^3P (C)	8.41 volts
$A\ ^1\Pi$	^1D + ^1D	3.58 „
$B\ ^1\Sigma$	^1D + ^1S	2.28 „
$a\ ^3\Pi$	^3P + ^1D	3.68 „
$a'\ ^3\Sigma$	^3P + ^1S	3.94 „
$d\ ^3\Pi$	^3P + ^1S	3.18 „

We will still point to the fact that on the whole in 4 band-systems of CO the phenomenon of predissociation has been found. Besides the three cases mentioned above, a predissociation has still been detected in the third positive group[1]). This is caused by the same level which is responsible for predissociation in the ÅNGSTRÖM-bands (see figure 1).

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[1] That it cannot be lower than this value, will be discussed in detail in a paper soon to appear in Physica.

From the value of the dissociation energy of CO we are able to calculate the heat of sublimation of solid carbon. We use the well-known equation:

$$C_{diam.} + \tfrac{1}{2} O_2 = CO + Q,$$

where Q is the heat of combustion. It then follows that:

$$Q = D_{CO} - \tfrac{1}{2} D_{O_2} - S_C,$$

where D is the dissociation energy and S is the heat of sublimation. Taking for Q the value 27.6 kcal, for D_{CO} the above value of 193.9 kcal and for D_{O_2} the value of 5.09 volts = 118.4 kcal according to HERZBERG[2]), we find for $S = 107.6$ kcal., which is much lower than the value found by other methods[3]).

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te Groningen.

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[1]) F. BRONS, Nature **135**, 873, 1935.

[2]) G. HERZBERG, Zs. f. phys. Chem. **10**, 189, 1930.
R. FRERICHS, Phys. Rev. **36**, 398, 1930.

[3]) 139 kcal by H. KOHN and M. GUCKEL, Zs. f. Phys. **27**, 305, 1924, and 177 kcal by A. L. MARSHALL and F. J. NORTON, J. Amer. Chem. Soc. **55**, 431, 1933.

Astronomy. — *Mittlere Lichtkurven von langperiodischen Veränderlichen.* XXV. *V* 20 = *ST Cygni.* Von A. A. NIJLAND.

(Communicated at the meeting of October 26, 1935).

Instrumente *S* und *R*. Da der Stern im Maximum selten heller als 10^m wird, wurde der Sucher nur ausnahmsweise benutzt. Die Beobachtungen wurden alle auf *R* reduziert; die Reduktion *R*—*S* beträgt $-0^m.35$. Spektrum M6e (HA **79**, 190). Gesamtzahl der Beobachtungen 673 (von 2416936 bis 2428077). Es wurden wieder, wie in allen früheren Mitteilungen, die in zwei Instrumenten angestellten Schätzungen nur einmal gezählt. Zwei Beobachtungen wurden verworfen (2424966 und 7676), und so bleiben 671 Schätzungen für die Reduktion übrig.

Karte: HAGEN, *Atlas Stell. var. Series VII.*

Die Tabelle I gibt eine Übersicht der benutzten Vergleichsterne. Die Wahl passender Objekte bot in dem reichen Felde keinerlei Schwierigkeiten, und ich fühlte mich deshalb bei der Beobachtung dieses Sterns recht sicher. Stern *a* ist BD + 54°.2375; seine in Potsdam gemessene Helligkeit, $9^m.46$, verdanke ich einer brieflichen Mitteilung von weiland G. MÜLLER. Für die

TABELLE I. Die Vergleichsterne.

*	HAGEN	St.	GRAFF	HA 74 red.	PD red.	*H*
a	11	41.8	—	$9^{\mathrm{m}}.50$	$9^{\mathrm{m}}.29$	$9^{\mathrm{m}}.44$
b	19	35.2	$10^{\mathrm{m}}.14$	10.30	Grenze	10.14
c	39	29.3	10.65	—	$11^{\mathrm{m}}.01$	10.75
d	44	23.2	11.49	—	—	11.39
e	45	23.0:	11.58	—	—	11.41:
f	48	17.8	11.99	11.83	—	11.96
g	50	13.0	—	—	—	12.47
h	57	7.7	—	—	—	13.03
j	—	3.7:	—:	—	—	13.45:
l	60	2.7	13.38	—	—	13.56
k	59	2.1	—	—	13.50	13.62
ξ	61	0.0	13.84	—	—	13.84
m	—	—	—	—	—	13.91:

Reduktion auf das System der HP wurde $-0^{\mathrm{m}}.17$ genommen. Die Sterne *e*, *j* und *m* kamen nur ausnahmweise zur Verwendung; *j* und *m* trifft man nicht bei HAGEN an; ihre Koordinaten in bezug auf den Veränderlichen sind:

$$j:\ \Delta\alpha = +0'.4, \qquad \Delta\delta = -2'.6,$$
$$m:\ \qquad -0.7 \qquad\qquad +1.6.$$

Die Sterne *c* und *d* wurden 3-mal (2417153, 7207 und 7712) an die Grenze von *S* angeschlossen. Für *c* ergibt sich hieraus der Wert $11^{\mathrm{m}}.01$. Stern *k* wurde im Laufe der Jahre oft, als der Veränderliche im Minimum war, an die Grenze von *R* angeschlossen; als Mittel aus 17 Schätzungen erhielt ich $13^{\mathrm{m}}.50$. Die photometrischen Helligkeiten von GRAFF wurden dem *Atlas Stell. var.* entnommen. Die Grössen aus HA 74 erhielten zur Reduktion auf die GRAFFschen Zahlen eine Nullpunkts-Korrektion von $+0^{\mathrm{m}}.67$. Wie aus der Tabelle I ersichtlich, steht die Stufenskala in sehr befriedigendem Einklang mit den photometrischen Helligkeiten der Vergleichsterne. Sie bezieht sich auf die Grösse $12^{\mathrm{m}}.0$; der Stufenwert ist $0^{\mathrm{m}}.105$.

Es liegen nur 20 Schätzungen der Farbe vor, meistens aus den Jahren 1905 bis 1909. Die Farbe wurde immer 3^{c} oder 4^{c} geschätzt, und zwar bei einer Helligkeit des Veränderlichen zwischen den Grenzen $9^{\mathrm{m}}.8$ und $11^{\mathrm{m}}.1$. Das allgemeine Mittel ist $3^{\mathrm{c}}.55$.

Die *Figur 1* enthält die Beobachtungen, alle auf *R* reduziert. Die Reihe der Abweichungen (Beobachtung minus Kurve) zeigt 204 Plus-, 264

Minuszeichen, 203 Nullwerte, 185 Zeichenfolgen, 282 Zeichenwechsel. Das Mittel der absoluten Werte der Abweichungen ist $0^{m}.087$. Sehr auffallend ist der grosse Überschuss der Zeichenwechsel; die Kurve folgt scheinbar den eingetragenen Punkten der Graphik zu genau und hätte glätter gezogen werden können. Dafür sprechen auch die grosse Zahl von Nullwerten, und der geringe Wert der durchschnittlichen Abweichung.

Ein Einfluss des Mondscheines auf die Helligkeitsschätzung ist kaum nachweisbar. Es verteilen sich auf 151 bei Mondschein angestellte Beobachtungen die Abweichungen wie folgt: 47 Plus-, 62 Minuszeichen, 42 Nullwerte.

Die Tabelle II enthält die aus der Kurve abgelesenen Epochen der Minima *m* und der Maxima *M*. Die Spalte *R* wurde mit den Elementen:

$$2422305^{d} + 334^{d}\,E \text{ (für die Minima)}$$

und

$$2422473 + 334\,E \text{ (für die Maxima)}$$

gerechnet. Die übrigbleibenden *B—R* sind zu gross und sie zeigen überdies einen stark systematischen Charakter. Dabei fällt es auf, dass der sonst meistens so deutlich ausgesprochene Parallelismus zwischen Minima und Maxima hier fehlt, namentlich am Ende der Reihe. Bei den Minima würde die Reihenfolge der Vorzeichen (anfangs überwiegend +, in der Mitte — oder um Null herum, am Ende wieder +) auf eine Verlängerung der Periode weisen — etwa von 330^{d} zu 337^{d} in dem hier diskutierten Zeitraum 1905—1935. Bei den Maxima könnte man eher auf eine konstante Periode schliessen, welche dann aber etwas kleiner als 334^{d} genommen werden müsste. Sehr deutlich ist allerdings die Abnahme der *B—R* von + nach — hier nicht ausgesprochen. Und so habe ich es trotz der auf der Hand liegenden Unsicherheit gewagt, die beiden Reihen *B—R* in eine Graphik zu kombinieren, und sie durch eine Parabel darzustellen. Das Resultat ist das Elementensystem *F*:

$$\left.\begin{array}{ll}\text{Minima:} & 2422295^{d}\\ \text{Maxima:} & 2464\end{array}\right\} + 334^{d}\,E + 0^{d}.098\,(E-3)^{2}.$$

Obwohl die Berücksichtigung des quadratischen Gliedes die Quadratsummen der Abweichungen für die Minima und die Maxima zusammen von 13877 auf 9248 herabdrückt, ist die Darstellung der beobachteten Epochen durch die Formel *F* keineswegs befriedigend zu nennen.

Die *G und L* (II, 277) gibt für die aus 17 Maxima abgeleitete Periode $333^{d}.5$, mit der Bemerkung, dass die Periodenlänge wahrscheinlich Schwankungen unterworfen ist; doch sei hervorgehoben, dass sich unter diesen Maxima 10 von mir beobachtete vorfinden. Auch bei diesem Stern tritt wieder deutlich zutage, dass ein Zeitraum von 30 Jahren zu einer einigermassen befriedigenden Diskussion der beobachteten Epochen nicht ausreicht; diese muss späteren Untersuchungen vorbehalten bleiben.

PRAGER's Katalog für 1935 gibt den Periodenwert $333^{d}.3$, und das aus

A. A. NIJLAND: MITTLERE LICHTKURVEN VON LANGPERIODISCHEN VERÄNDERLICHEN. XXV. V 20 = ST CYGNI.

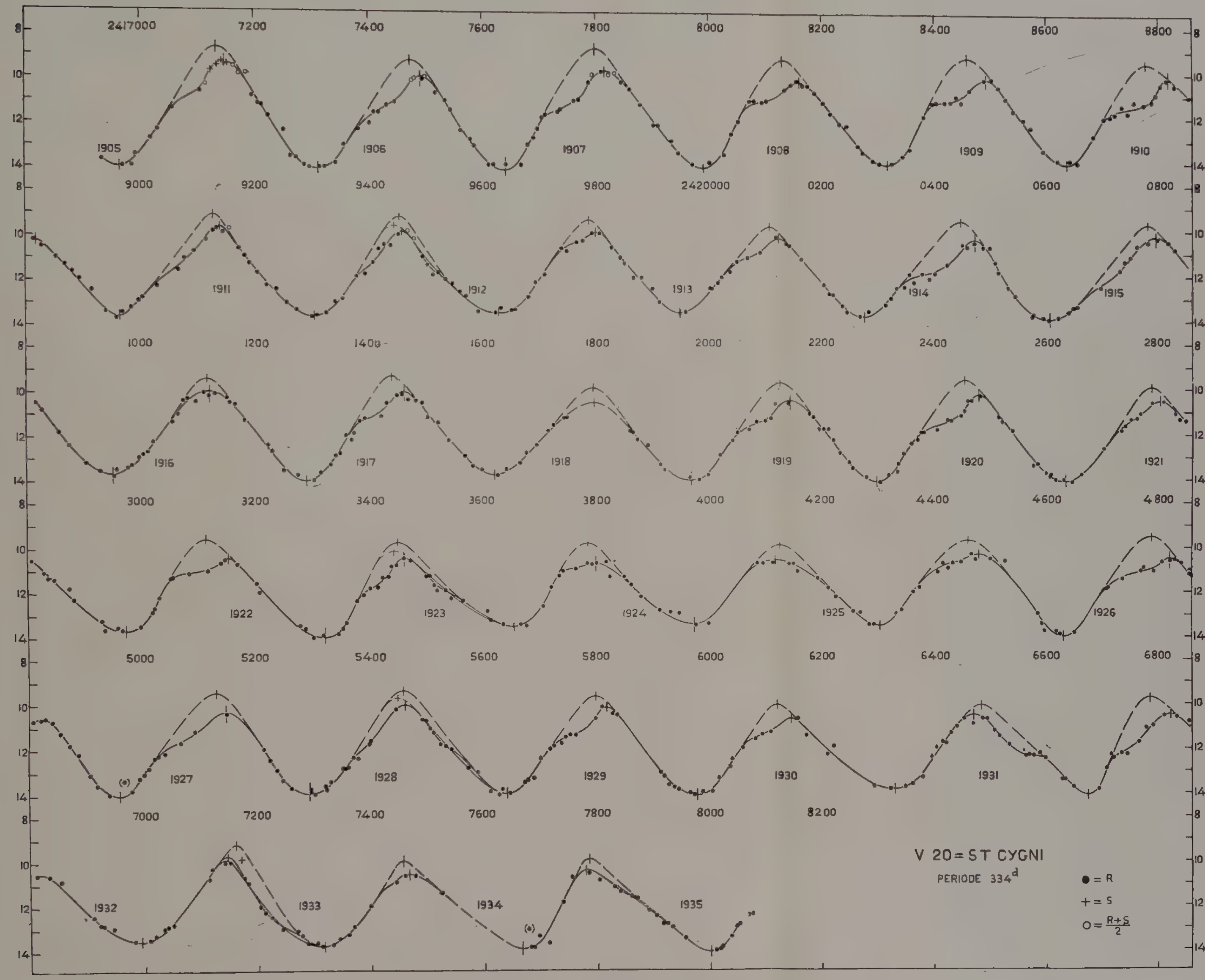

Fig. 1.

Proceedings Royal Acad. Amsterdam, Vol. XXXVIII, 1935.

TABELLE II.

E	Minima m					Maxima M				
	B	v	R	B—R	B—F	B	v	R	B—R	B—E
— 16	241 6964	m 14.0	6961	+ 3	—22	241 7149	m 9.4	7129	+20	— 6
— 15	7312	14.1	7295	+17	— 5	7492	10.0	7463	+29	+ 6
— 14	7642	14.1	7629	+13	— 5	7816	9.8	7797	+19	0
— 13	7991	14.1	7963	+28	+13	8162	10.2	8131	+31	+15
— 12	8317	14.0	8297	+20	+ 8	8494	10.2	8465	+29	+16
— 11	8638	14.0	8631	+ 7	— 2	8817	10.2	8799	+18	+ 8
— 10	8964	13.6	8965	— 1	— 8	9139	9.6	9133	+ 6	— 2
— 9	9305	13.6	9299	+ 6	+ 2	9458	9.9	9467	— 9	—14
— 8	9629	13.5	9633	— 4	— 6	9800	9.9	9801	— 1	— 4
— 7	9948	13.5	9967	—19	—19	242 0125	10.2	0135	—10	—11
— 6	242 0276	13.7	0301	—25	—23	0473	10.3	0469	+ 4	+ 5
— 5	0606	13.9	0635	—29	—25	0795	10.2	0803	— 8	— 5
— 4	0950	13.7	0969	—19	—14	1119	10.0	1137	—18	—14
— 3	1290	14.0	1303	—13	— 7	1462	10.0	1471	— 9	— 4
— 2	1620	13.7	1637	—17	—10	1797 :	10.5 :	1805	— 8	— 2
— 1	1967	14.0	1971	— 4	+ 4	2145	10.4	2139	+ 6	+13
0	2297	14.0	2305	— 8	+ 1	2480	10.2	2473	+ 7	+15
+ 1	2634	14.0	2639	— 5	+ 5	2803	10.5	2807	— 4	+ 5
+ 2	2972	13.7	2973	— 1	+ 9	3150	10.4	3141	+ 9	+18
+ 3	3320	13.9	3307	+13	+23	3460	10.4	3475	—15	— 6
+ 4	3653	13.5	3641	+12	+22	3798	10.6	3809	—11	— 2
+ 5	3971	13.4	3975	— 4	+ 6	4116	10.5	4143	—27	—18
+ 6	4301	13.5	4309	— 8	+ 1	4480	10.3	4477	+ 3	+11
+ 7	4630	14.0	4643	—13	— 5	4820	10.4	4811	+ 9	+16
+ 8	4959	14.0	4977	—18	—11	5143	10.3	5145	— 2	+ 4
+ 9	5290	14.0	5311	—21	—15	5460	10.0	5479	—19	—14
+ 10	5640	14.0	5645	— 5	0	5816	10.1	5813	+ 3	+ 7
+ 11	5976	14.1	5979	— 3	+ 1	6144	10.6	6147	— 3	0
+ 12	6330	13.8	6313	+17	+19	6469	10.5	6481	—12	—11
+ 13	6673	14.1	6647	+26	+26	6821	10.5	6815	+ 6	+ 5
+ 14	6994	13.5	6981	+13	+11	7146	9.9	7149	— 3	— 6
+ 15	7316	13.8	7315	+ 1	— 3	7466	10.5	7483	—17	—22
+ 16	7666 :	14.0 :	7649	+17	+10	7779	10.4	7817	—38	[—46]
+ 17	8001	14.0	7983	+18	+ 9		10.22			± 9
		13.85			±10					

sämtlichen von mir seit d. J. 1905 in den *Astr. Nachr.* mitgeteilten Epochen der Minima und Maxima abgeleitete allgemeine Mittel ist 334^{d}.

Die extremen Werte des Lichtwechels sind:

$$\left.\begin{array}{l}\text{Minimum: } 13^{m}.85 \pm 0^{m}.043 \\ \text{Maximum: } 10\ .21 \pm 0\ .050\end{array}\right\} \text{(m.F.)}$$

Die Amplitude beträgt somit $3^{m}.64$. Beim Maximum zeigt die Reihe der Abweichungen vom Mittelwert ein Zuviel an Zeichenfolgen. Man bekommt den Eindruck, dass das grösste Licht in den Jahren 1905—1935 etwas schwächer ist geworden, etwa von $10^{m}.3$ bis $10^{m}.8$.

Die Bildung einer mittleren Kurve war bei diesem Stern mit erheblichen Schwierigkeiten verknüpft. Die Betrachtung der *Figur 1* lehrt, dass sich bei vielen Maxima im Aufstieg mehr oder weniger deutlich ausgeprägte Verzögerungen bemerkbar machen. Bei den Maxima 2417816, 8162, 8494, 8817, 2420473, 1462, 2145, 2480, 3150 und 6821 bilden sie sich zu wirklichen Buckeln heraus. In diesen und auch noch in vier weiteren Fällen (2417492, 2423460, 5816 und 7146) lässt sich der Wendepunkt ziemlich sicher bestimmen. Es bleiben dann aber 19 Maxima übrig, bei denen der Wendepunkt entweder gar nicht existiert, oder kaum festzulegen ist. Dazu kommt nun die oben schon genannte Tatsache, dass in den Abweichungen Beobachtung minus Kurve die Zeichenwechsel abnormal stark überwiegen. Ich habe die Kurve so gelassen, wie ich sie nun einmal gezeichnet hatte, stehe aber den sehr flauen sekundären Wellen etwas misstrauisch gegenüber: hätte ich die Kurve glätter gezogen, wozu mir der Überschuss der Zeichenwechsel das vollste Recht gibt, so wären mehrere der nicht überdeutlichen Wendepunkte ganz und gar verschwunden.

Auch der absteigende Ast zeigt hier und da eine Verzögerung: beim Maximum 2426469 ist sie durch zahlreiche Beobachtungen vollkommen verbürgt, bei den Maxima 2419458, 2423460, 5460, 7146 und 7779 gilt aber wieder die Bemerkung, dass man die Wendepunkte und damit ein Paar überzählige Zeichenwechsel los wird, wenn man die Kurve etwas gerader zieht.

Schliesslich habe ich bei der Bildung der Kurve die Wendepunkte ganz ausser Acht gelassen. Sie spielen selbstverständlich dennoch ihre Rolle in der mittleren Kurve (Tabelle III), welche sich aus den beiden Teilkurven, der Kurve des grössten und der Kurve des kleinsten Lichtes, zusammenstellt.

Ich war etwas enttäuscht, erfahren zu müssen, dass sich bei *V 20 Cygni* die beiden Teilkurven nicht befriedigend an einander anschliessen. Der Fall hat sich in meinen bisherigen Bearbeitungen der mittleren Lichtkurven noch nie dargeboten und ist m.E. dem Non-Parallelismus der beiden Hauptepochen zuzuschreiben, von dem oben die Rede war.

Es wurde nun wieder versucht, die Kurve von der „Störung" zu befreien. Obwohl es bei mehreren Maxima, namentlich denjenigen wo kein Wendepunkt vorhanden ist, fraglich erscheinen kann, ob der Stern bei der

TABELLE III. Die mittlere Lichtkurve.

Phase	v	Phase	v	Phase	v	Phase	v
-90^{d}	$12^{\mathrm{m}}.05$	0	$13^{\mathrm{m}}.85$	$+90^{\mathrm{d}}$	$11^{\mathrm{m}}.67$	+ 180	$10^{\mathrm{m}}.32$
— 80	12.32	$+10^{\mathrm{d}}$	13.78	+ 100	11.49	+ 190	10.54
— 70	12.60	+ 20	13.64	+ 110	11.35	+ 200	10.80
— 60	12.86	+ 30	13.42	+ 120	11.17	+ 210	11.08
— 50	13.11	+ 40	13.11	+ 130	10.97	+ 220	11.37
— 40	13.33	+ 50	12.78	+ 140	10.74	+ 230	11.66
— 30	13.52	+ 60	12.40	+ 150	10.47	+ 240	11.95
— 20	13.68	+ 70	12.12	+ 160	10.30	+ 250	12.22
— 10	13.80	+ 80	11.87	+ 170	10.21		

Aufhellung wirklich eine Störung erleidet, so stehen diesen zweifelhaften oder vielleicht sogar negativen Fällen so viele Fälle von ausgesprochen positiver Evidenz gegenüber — siehe z.B. in der *Figur 1* die obere Reihe — dass ich, wie früher bei *S Ursae Majoris* und *R Cygni*, angenommen habe, dass sämtliche Aufhellungen einer Störung unterliegen. Sie tritt dann meistens im Aufstieg auf, mitunter aber unweit des Maximums, und wenigstens einmal im Abstieg (beim gut kontrollierten Maximum 2426469); die Maxima 2419458, 2423460, 5460, 7146 und 7779 bleiben nach der oben bei der Besprechung der Wendepunkte gemachten Bemerkung zweifelhaft.

Wie dem auch sei, ich habe sämtliche Maxima so gut wie möglich nach dem bisher immer innegehaltenen Prinzip vervollständigt, dass der ungestörte Kurvenzug sich dem beobachteten sowohl beim Auf- wie beim Abstieg tunlichst gut anzuschmiegen hat (Tabelle IV). Es kam mir aber ratsam vor, die 5 zweifelhaften Maxima in der weiteren Diskussion ausser Acht zu lassen, so wie auch die an und für sich schon recht unzuverlässigen Maxima 1797 und 4116. Die übrigen (26 Stück) wurden mit den Elementen *R*:

$$2422457^{\mathrm{d}} + 334^{\mathrm{d}} E$$

und den Elementen *F*:

$$2422446^{\mathrm{d}} + 334^{\mathrm{d}} E + 0^{\mathrm{d}}.098\,(E-3)^2$$

verglichen.

Die maximale Helligkeit wird jetzt: $v = 9^{\mathrm{m}}.50 \pm 0^{\mathrm{m}}.060$ (m.F.).

Die Teilkurve *A* der ungestörten Maxima (*Fig. 2*) schliesst sich der-

TABELLE IV. Ungestörte Maxima.

E	B	v	R	B—R	B—F	E	B	v	R	B—R	B—F
—16	241 7131	m 8.7	7113	+18	— 6	+ 1	242 2787	m 9.9	242 2791	— 4	+ 7
—15	7473	9.3	7447	+26	+ 5	+ 2	3110	9.6	3125	—15	— 4
—14	7799	8.8	7781	+18	+ 1	+ 3	[3448	9.7]	3459	—	—
—13	8131	9.3	8115	+16	+ 2	+ 4	3783	9.8	3793	—10	+ 1
—12	8459	9.2	8449	+10	— 1	+ 5	[4126:	9.9:]	4127	—	—
—11	8777	9.5	8783	— 6	—14	+ 6	4460	9.7:	4461	— 1	+ 9
—10	9126:	9.1	9117	+ 9	+ 3	+ 7	4788	9.5	4795	— 7	+ 2
— 9	[9454:	9.2]	9451	—	—	+ 8	5127	9.4	5129	— 2	+ 6
— 8	9787	9.4	9785	+ 2	+ 1	+ 9	[5456:	9.4]	5463	—	—
— 7	242 0107	9.7	0119	—12	—11	+10	5797	9.6	5797	0	+ 6
— 6	0447	9.5	0453	— 6	— 3	+11	6119	10.0	6131	—12	— 7
— 5	0780	9.7	0787	— 7	— 2	+12	6483	10.0	6465	+18	+21
— 4	1114:	9.4:	1121	— 7	— 1	+13	6785	9.7	6799	—14	—13
— 3	1440	9.3	1455	—15	— 8	+14	[7160	9.2]	7133	—	—
— 2	[1794:	9.8:]	1789	—	—	+15	7455	9.9	7467	—12	—15
— 1	2127	9.6	2123	+ 4	+13	+16	[7785:	9.9]	7801	—	—
0	2455	9.5	2457	— 2	+ 8			m 9.50			± 6

jenigen der Minima sehr gut an. Für die Schiefe der ungestörten Kurve findet man

$$\frac{M-m}{P}=0.452.$$

Zum Schluss wurde die Differenzkurve *A—B* gebildet, welche für den grösseren Teil symmetrisch verläuft. Das Minimum, zu $1^{m}.14$, fiele auf 2422426, also 20 Tage vor dem ungestörten Maximum; der Veränderliche würde beim Aufstieg eine Verfinsterung erleiden, welche ihn von 65 % seines Lichtes beraube. Dass es von $+180^{d}$ an so lange dauert, bis die beiden Kurven *A* und *B* sich wieder berühren, liegt grössenteils an dem abnormalen Verlauf der zweifelhaften Maxima. Ich habe deshalb mit Ausschaltung der schon bei der Diskussion der Tabelle III ausgeschlossenen Maxima sowie des abnormalen Maximums 6469 auch die einzelnen Differenzkurven *A—B* bestimmt, zusammen 25 an der Zahl. Bringt man die Minimal-Epochen dieser Differenzkurven zur Deckung, und bildet man die mittlere Kurve *D*, so gestaltet sich diese (s. die *Fig. 2*) fast vollkommen symmetrisch. Der Unterschied gegen die Kurve C ist klein. Das Minimum fällt jetzt etwas später (2422430 oder 16 Tage vor dem

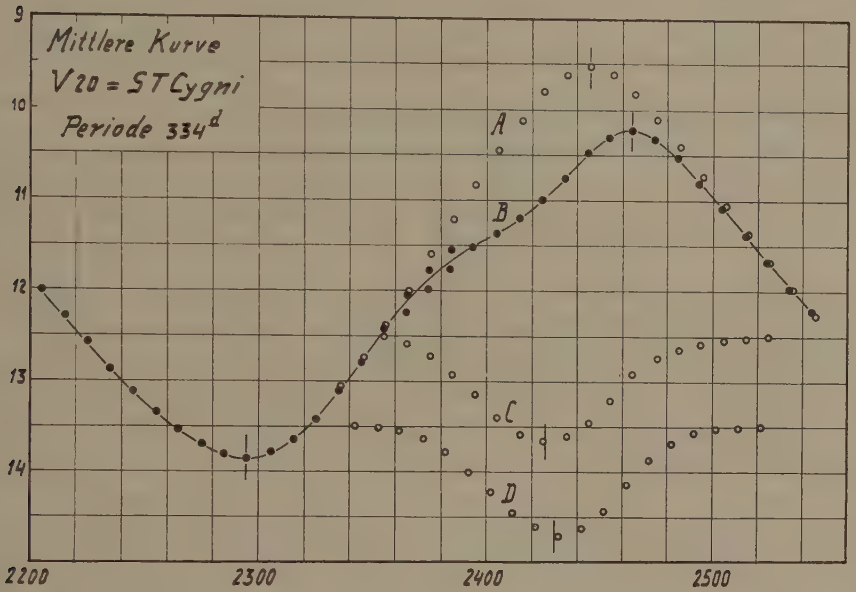

Fig. 2.

ungestörten Maximum) und die Verfinsterung ist etwas tiefer ($1^m.20$), so dass der Lichtverlust etwas grösser ist (67 %). Ich halte die zweite Lösung für die wahrscheinlichere.

Alles zusammengenommen, das abweichende Maximum 6469, die stark verfrühte Epoche 2427779 ($E = +16$), der unbefriedigende Anschluss der beiden Teilkurven, die Unsicherheit in der Bildung der ungestörten Kurve, macht *V 20 Cygni* den Eindruck eines langperiodischen Veränderlichen, bei dem die sekundären Unregelmässigkeiten stärker als sonst hervortreten. An der Qualität der Schätzungen liegt es m.E. sicher nicht: die reiche Auswahl passender Vergleichsterne verleiht dem Beobachter bei diesem Stern ein Gefühl der Sicherheit.

Utrecht, Oktober 1935.

Chemistry. — *On Some Complex Dipyridyl-Salts of Nickel and Copper.*

By F. M. JAEGER and J. A. VAN DIJK.

(Communicated at the meeting of October 26, 1935).

§ 1. As a completion of the data previously published 1) about the complex salts of *dipyridyl* and bivalent *nickel*, we here give a review of the results obtained in the study of the interaction of the base mentioned with *nickel nitrate* and *nickel chloride*. At the same time a correction of the crystallographical data 2) concerning *tridipyridyl-copper chloride* $(+ 7 H_2O)$ is inserted at the end of this paper.

§ 2. *Nickel nitrate.* If to a solution of *nickel nitrate* one, two or three equivalents of dipyridyl respectively are added, these solutions on slow evaporation at room-temperature all in the first instance will deposit a red salt, which on analysis proves to be a *tridipyridyl-nickel nitrate* of the composition 3): $\{Ni\ (Dipyr)_3\}\ (NO_3)_2 + 5 H_2O$; analysis yielded: 7.87 % Ni; 12.00 % H_2O and 15.20 % N; calculated: 7.92 % Ni; 12.15 % H_2O and 15.12 % N.

The compound: $\{Ni\ (Dipyr)_3\}\ (NO_3)_2 + 5 H_2O$ crystallizes from its concentrated aqueous solutions at room-temperature in the shape of red, elongated tables. The crystals are badly built; all occurring faces, except those of the basis, are striated parallel to the basal plane and yield very bad, multiple reflections.

The crystals are optically uniaxial; the double refraction is positive.

Hexagonal (di-)-bipyramidal.

$a : c = 1 : 0.802.$

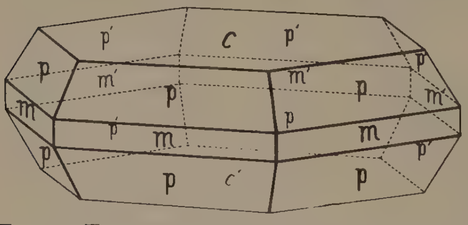

Fig. 1. Tri-dipyridyl-Nickel nitrate $(+ 5 H_2O)$.

Forms observed: $c = \{0001\}$, lustrous and ordinarily well reflecting; $p = \{20\bar{2}1\}$, broader than $m = \{1010\}$, both yielding very dull reflections; in some cases $\omega = \{10\bar{1}1\}$ was indicated, but extremely small.

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1) F. M. JAEGER and J. A. VAN DIJK, these Proceedings, **37**, (1934), 10.

2) Ibidem, **37**, (1934). 399, 400.

3) P. PFEIFFER and K. QUEHL give $6 H_2O$, Berl. Ber. **64**, (1931), 2667, etc.; cf. also: Zeits. f. Anorg. Chemie, **215**, (1933), 278. We never found more than $5 H_2O$.

Angular Values:	*Observed:*	*Calculated:* (from spectrogr. data)
$c:p=(0001):(20\bar{2}1)=$*	60°19′—61°40′	61°38′
$p:m=(20\bar{2}1):(10\bar{1}1)=$	29 41 —28 20	28°22′
$c:\omega=(0001):(10\bar{1}1)=$	43° —48° (estimated)	47°43′

From oscillation-spectrograms round [0001] (*Fe-α*-radiation), the dimensions of the elementary cell were found to be: $a_0 = 13.5$ A.U. and $c_0 = 10.8$ A.U.; from a LAUE-pattern on {0001} the dihexagonal symmetry could be deduced with a fair probability. The cell contains two molecules of the salt; *d* (calculated) = 1,435; value observed: 1,46.

§ 3. From the solution with 2 equivalents of dipyridyl, after deposition of some tridipyridyl-salt, pale violet prisms or needles are obtained, which in most cases form intergrowths and clusters of crystals. Because their angular values oscillate within rather wide limits, they can only be measured with difficulty; thus for instance their vertical zone is rather badly built and shows vicinal forms. Analysis yielded: 10.85 % *Ni*; 22.53 % (NO_3); 15.12 % *N*. The salt is the *di*-dipyridyl-salt of the composition: $\{Ni\,(Dipyr)_2\}\,(NO_3)_2 + 3H_2O$; theoretically: 10.69 % *Ni*; 22.59 % (NO_3); and 15.3 % *N*.

Monoclinic-prismatic.

$a:b:c = 0.3912:1:0.3825;\ \beta = 73°\ 43'.$

Forms observed: $a = \{100\}$, mostly predominant; $m = \{110\}$, narrow, well reflecting; $p = \{210\}$ and $s = \{610\}$, both very narrow and yielding

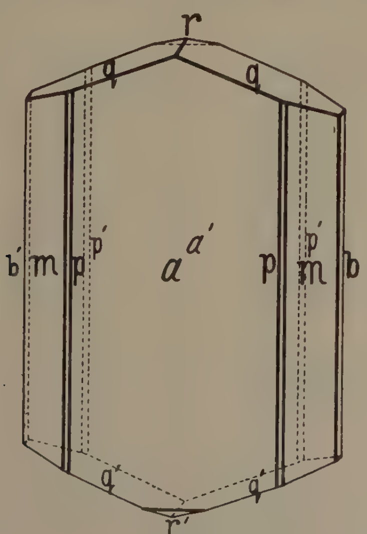

Fig. 2. Di-dipyridyl-Nickel nitrate $(+ 3\,H_2O)$.

bad reflections; $b = \{010\}$, extremely narrow, reflecting better than s and p; $q = \{011\}$, yielding good reflections; $r = \{\bar{4}03\}$, small and dull. The habitus is flat prismatic (Fig. 2).

Angular Values:	*Observed:*	*Calculated:*
$a : m = (100) : (110) =^{*}$	20° 35′	—
$q : q = (011) : (0\bar{1}1) =^{*}$	40 18	—
$m : q = (110) : (011) =^{*}$	68 27	—
$r : q = (\bar{4}03) : (011) =$	64°—65°	64° 52½′
$m : p = (110) : (210) =$	8°— 9°	9 57
$p : s = (210) : (610) =$	ca. 7°	6 38
$s : a = (610) : (100) =$	ca. 3½°	4 0
$b : m = (010) : (110) =$	69 25	69 25
$m : m = (110) : (\bar{1}10) =$	138 50	138 50
$b : q = (010) : (011) =$	69 51	69 51
$m : r = (\bar{1}10) : (\bar{4}03) =$	ca. 47°	46 57

The crystals are very brittle, but no distinct cleavage was observed. The optical axial plane is horizontal; on a normal extinction. The crystals are strongly dichroïtic: on {100} for vibrations parallel to the c-axis pale pink, for those perpendicular to these, blue.

§ 4. From the solution with 1 equivalent of dipyridyl, which originally assumes a lilac-red colour, but gradually turns a dark blue, first some red crystals of the *tri*dipyridyl-salt are deposited. Later on blue crystals appear. On analysis they proved to yield: 14.81 % Ni: 13.89 % N and 30.91 % (NO_3). Although they evidently are not yet quite pure, there can be no doubt that they represent the *monodipyridyl*-salt of the composition:

$\left\{ Ni \begin{matrix} (Dipyr) \\ (H_2O)_2 \end{matrix} \right\} (NO_3)_2 + H_2O$, which requires: 14.94 % Ni; 14.26 % N and 31.57 % (NO_3).

Hitherto this compound could not be obtained in the form of measurable crystals.

Nickel nitrate: $Ni(NO_3)_2 + 6H_2O$, therefore, proves to be able of generating all 3 types of complex dipyridyl-salts.

§ 5. *Nickel chloride.* From the aqueous solutions with 3 or 2 equivalents of the base we hitherto could isolate only the *tridipyridyl*-salt in beautiful, flat, dark red crystals of the composition: $\{Ni\ (Dipyr)_3\}\ Cl_2 + 7H_2O$; analysis yielded the following results: Ni : 8.10 %; N : 11.51 %;

H_2O at 100° C.[1]) : 17.3 %; theoretically: Ni : 8,11 %; N : 11.61 %; H_2O : 17.4 %.

The crystals have the shape of thick parallelograms or of elongated, hexagonally bordered needles. They are soft and easily deformable.

Monoclinic-prismatic.

$a:b:c = 0.6113:1:2.0981$; $\beta = 72°55\frac{1}{2}'$.

Forms observed: $c = \{001\}$, predominant, very lustrous and yielding excellent reflections; $m = \{110\}$, broad and giving sharp images; $q = \{011\}$, well developed, yielding good reflections; $o = \{112\}$, always present, narrow, well measurable; $a = \{100\}$, narrow, often absent, but if present, yielding weak but good reflections; $\omega = \{\bar{1}12\}$ and $s = \{\bar{1}14\}$, narrow, well measurable, ω ordinarily broader than s. The habitus is tabular parallel to {001}, either somewhat elongated parallel to the *b*-axis or, rarely, parallel to the *a*-axis.

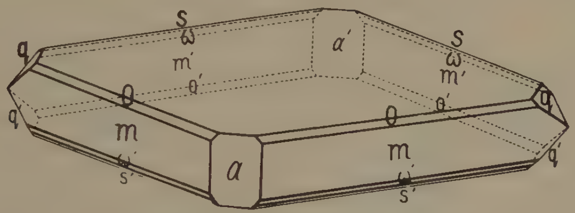

Fig. 3. Tri-dipyridyl-Nickel chloride (+ 7 H_2O).

Angular Values:	*Observed*:	*Calculated*:
$c:m = (001):(110) =^*$	75° 19′	—
$c:q = (001):(011) =^*$	63 30	—
$a:m = (100):(110) =^*$	30 18	—
$c:o = (001):(112) =$	51 41	51° $57\frac{1}{3}'$
$o:m = (112):(110) =$	23 18	23 $21\frac{2}{3}$
$m:\omega = (110):(11\bar{2}) =$	28 58	29 8
$\omega:s = (11\bar{2}):(11\bar{4}) =$	23 30	23 $26\frac{1}{3}$
$c':s = (00\bar{1}):(11\bar{4}) =$	52 0	52 $6\frac{2}{3}$
$m:q = (110):(012) =$	55 42	55 $37\frac{1}{2}$

Imperfectly cleavable parallel to {001}.

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[1]) The water content (7 H_2O) is in perfect accordance with the isomorphism of this salt with corresponding *zinc-* and *copper*-salts. In the literature (G. T. MORGAN and F. H. BURSTALL, Journ. Chem. Soc. London, (1931), 2213) is given: 6 H_2O; but the salt loses over P_4O_{10} only 6 molecules of water, the seventh however at 100° C.

The crystals are feebly dichroïtic: for vibrations parallel to {010} on {001} paler red than for those parallel to the *b*-axis. The axial plane is perpendicular to {010}; on {001} two axial images at the border of the field and no exactly determinable extinction. The first bisectrix is almost perpendicular to {001}.

The crystals are isomorphous with the corresponding *zinc-* and *copper-*salts.

By heating of the tridipyridyl-salt, a loss of 38.62 % was observed; this corresponds (38.97 %) to (*1 Dipyridyl* $+ 7H_2O$). The product generated is the anhydrous *di-dipyridyl*-salt of PFEIFFER and TAPPERMANN[1]), which is not stable in solutions. If brought into water, its colour changes to a dark blue and it then dissolves to a blue or lilac solution, which gradually assumes a redder hue, finally giving the red *tri-dipyridyl*-salt.

§ 6. From a solution of *nickel chloride* with 1 equivalent of dipyridyl, a solution was obtained which originally had a reddish blue colour, turning rather dark blue after some time. After a primary deposition of the red *tri*-dipyridyl-salt, the colour of the solution turns a still darker blue and finally it deposits *green* crystals, which on analysis proved to be an impure *monodipyridyl*-salt: 15.61 % Ni; 18.5 % Cl; 9.23 % N and 12.42 % H_2O. The last mother-liquor is dark green: from it a dull green, crystallized product was obtained, which proved to be the nearly pure salt: $\left\{ Ni \begin{matrix} (Dipyr) \\ (H_2O)_2 \end{matrix} \right\} Cl_2$, as the analysis yielded: 17.74 % Ni; 21.77 % Cl; 8.58 % N and 12.89 % H_2O; theoretically: 18.2 % Ni; 22.0 % Cl; 8.71 % N and 11.20 % H_2O. The salt is highly hygroscopic.

Evidently, in aqueous solutions, only the *mono-* and *tri-dipyridyl*-salts are stable; the former, however, has a tendency to change into the latter under the influence of the solvent.

§ 7. *Tridipyridyl-Copper chloride*: $\{Cu\ (Dipyr)\}_3\ Cl_2 + 7\,H_2O$ was formerly described as *rhombic*. A closer examination of some better developed crystals has, however, shown that the crystals are geometrically and optically pseudo-rhombic, in reality *monoclinic-prismatic*, just as the *zinc-* and *nickel*-salts.

Axial ratio:

$$a:b:c = 0.6114:1:2.1278;\quad \beta = 72°\ 54\tfrac{1}{2}'.$$

The violet, hexagonally bounded, flat crystals show the following forms: $c = \{001\}$, very lustrous and predominant; $m = \{110\}$, well developed, yielding good images; $q = \{011\}$, narrow, often striated parallel to the *a*-axis, giving dull reflections; $b = \{010\}$, often absent, but otherwise broader than q; $o = \{112\}$, very narrow, weakly reflecting like $\omega = \{11\bar{4}\}$ and $s = \{11\bar{2}\}$, which are often absent.

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[1]) P. PFEIFFER and F. TAPPERMANN, Zeits. f. Anorg. Chemie, 215, (1933), 277.

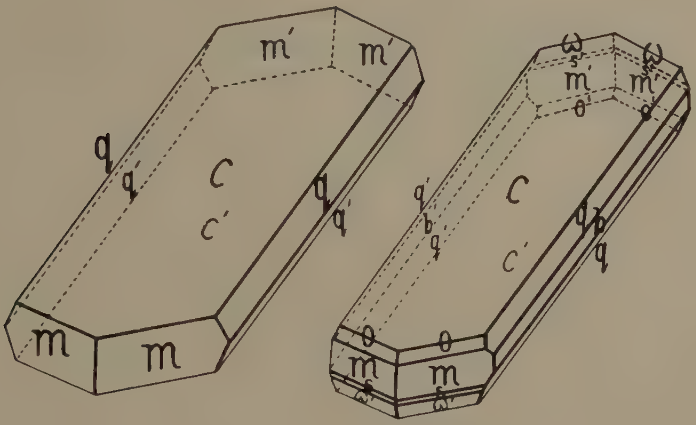

Fig. 4. Tri-dipyridyl-Copper chloride $(+7\,H_2O)$.

Angular Values:	*Observed:*	*Calculated:*
$c : m = (001) : (110) =$*	75° 18′	—
$c : q = (001) : (011) =$*	63 49	—
$m : m = (110) : (1\bar{1}0) =$*	60 36	—
$q : b = (011) : (010) =$	26 11	26° 11′
$c : o = (001) : (112) =$	52 20	52 9
$o : m = (112) : (110) =$	23 34½	23 45½
$b : m = (010) : (110) =$	59 42	59 42
$\omega : c' = (11\bar{4}) : (00\bar{1}) =$	52 40	52 38
$m : q = (011) : (110) =$	55 39	55 48
$m : s = (110) : (11\bar{2}) =$	28 40	28 34
$s : \omega = (11\bar{2}) : (11\bar{4}) =$	23 17	23 12

No distinct cleavability was observed.

The crystals are upon {001} only weakly dichroïtic, but very strongly on {010}: for vibrations parallel to the *a*-axis violet blue, for such parallel to the *c*-axis, bluish green. The plane of the optical axes is perpendicular to {010}; the first bisectrix is practically perpendicular to {001}. The apparent optical angle is only small.

All these salts: *nickel-, zinc-* and *copper*-salts are pseudo-rhombic, which is clearly shown when m is taken as {111} and $a = \{101\}$: then the angle β is very close to 90°; also in their optical behaviour they betray this approximation to rhombic symmetry.

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Chemistry. — *Der Einfluss des Dispersitätsgrades auf physikalisch-chemische Konstanten.* (Fünfte Mitteilung.) Von ERNST COHEN und J. J. A. BLEKKINGH JR.

(Communicated at the meeting of October 26, 1935).

EINLEITUNG.

In unserer vierten Mitteilung [1]) über den im Titel genannten Gegenstand wurde nachgewiesen, dass die Dichte des KCl bei gegebener Temperatur innerhalb der Versuchsfehler (± 0.0004 in den Einzelbestimmungen) denselben Wert aufweist falls es sich um Kristalle handelt deren mittlerer Durchmesser 0.1 mm bezw. 5 mm beträgt.

Da sich bei Untersuchungen über die Löslichkeit der Salizylsäure [2]) ergeben hatte, dass sich durch Abschrecken einer bei 100° C. gesättigten Lösung der Säure auf Zimmertemperatur die Bildung eines feindispersen Materials erzielen lässt, haben wir untersucht ob eine Differenz zwischen der Dichte (bei 25.00° C.) der so hergestellten Kristalle und der des grob kristallinischen Materials nachweisbar ist.

DER EINFLUSS DES DISPERSITÄTSGRADES AUF DIE DICHTE DER SALIZYLSÄURE.

A. *Das verwendete Material.*

1. Es gelangte bei unseren Versuchen ausschliesslich die bereits früher benutzte Säure der Firma POULENC, Usines du Rhône (puriss. cryst. grave) zur Verwendung, nachdem dieselbe ein Mal aus destilliertem Wasser umkristallisiert war. Durch Einwägen der während mehrerer Wochen über P_2O_5 in Vakuo getrockneten Säure, welche täglich aufs Neue zerrieben wurde und Titration derselben mit Barytlauge (0.01160 n), welche auf Adipinsäure [3]) eingestellt war, überzeugten wir uns von der Reinheit unseres Produktes.

B. *Das Verfahren zur Dichtebestimmung der festen Salizylsäure.*

2. Auch in diesem Falle, wie beim KCl, kam das ANDREAEsche Dilatometerverfahren zur Verwendung, dessen allgemeiner Gang in § 2

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[1]) Proc. Acad. Sci. Amsterdam **38**, 842 (1935).

[2]) ERNST COHEN und C. THÖNNESSEN, Proc. Acad. Sci. Amsterdam **35**, 441, 798, (1932); ERNST COHEN und W. A. T. COHEN—DE MEESTER, Proc. Acad. Sci. Amsterdam **37**, 270 (1934).

[3]) Vergl. F. TH. VAN VOORST, Chem. Weekblad **25**, 22 (1928).

unserer vierten Mitteilung beschrieben wurde. Da das Instrument in der von ANDREAE benutzten Form bisher nur zur Bestimmung der Dichte leichtlöslicher Stoffe mit grossem Temperaturkoeffizienten der Löslichkeit verwendet worden ist, handelte es sich in erster Linie darum ein Verfahren ausfindig zu machen, das uns in Stand setzt es auch in Fällen zu benutzen, in welchen der zu untersuchende Stoff (Salizylsäure) nur eine geringe Löslichkeit aufweist. In solchen Fällen gelingt es nicht eine grössere Menge des festen Stoffes aus der selbst bei höherer Temperatur gesättigten Lösung im Dilatometer auskristallisieren zu lassen, und da die Genauigkeit der Dichtebestimmung von der Menge des vorhandenen festen Stoffes abhängt, waren Massnahmen zu treffen, die dessen ungeachtet, das Erreichen hoher Genauigkeit ermöglichten.

Wir bestimmten, wie bereits beim KCl angegeben wurde, in jedem Versuch die Dichte der Lösung, welche sich im Dilatometer befand, sowie deren Konzentration durch Titrieren mit der genannten Barytlösung.

In dem hier vorliegenden Falle war ausserdem der Tatsache Rechnung zu tragen, dass die Salizylsäure mit Wasserdampf flüchtig ist, sodass Verdampfen des Wassers der im Dilatometer vorhandenen gesättigten Lösung zur Erzielung von Kristallen zu vermeiden war.

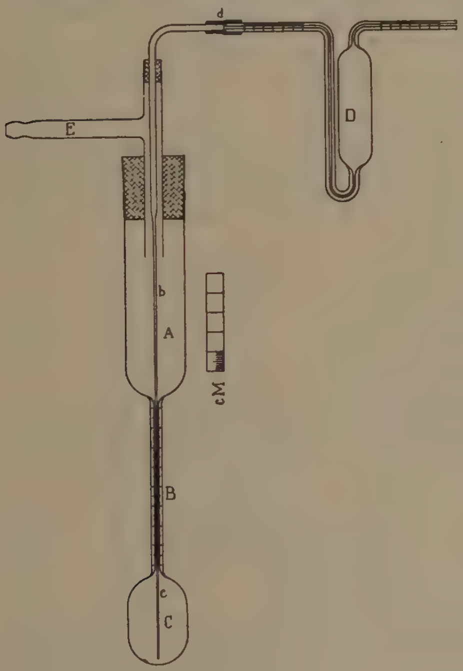

Fig. 1.

3. Folgendes Verfahren führte zum Ziel:

Man gibt etwa 1.5 g der scharf getrockneten Säure (vergl. § 1) in die Kugel *C* des zuvor gewogenen Apparates (Fig. 1) und wägt denselben aufs Neue. Sodann setzt man siedendes destilliertes Wasser in kleinen Mengen zu, wobei nur der untere Teil von *C* in einem Glyzerinbad erwärmt wird. Findet Sublimation der Säure statt, so setzt sich dieselbe wieder im Rohre *B* ab; mittels heissen Wassers lässt sich die sublimierte Säure in *C* spülen. In dieser Weise gelang es die Lösung in *C* und einem Teil von *B* unterzubringen. Sollte ein Teil derselben sich durch Zugabe von zu viel Wasser auch in *A* befinden, so brachten wir dieselbe mittels einer Kapillarpipette aus *A* und einem Teil von *B* in ein kleines Jenabecherglas, spülten mit Wasser nach, welches ebenfalls in das Becherglas gebracht wurde, und titrierten dessen Inhalt mit Barytlauge (und Neutralrot als Indikator) um die Menge der Säure, welche nicht in das Dilatometer gelangt war, festzustellen.

Nachdem sich nunmehr in der sogleich zu beschreibenden Art und Weise kleine, bezw. grosse Kristalle in dem Dilatometer gebildet hatten, ermittelten wir durch Ausführung der in unserer vierten Mitteilung (§§ 6—10) beschriebenen Manipulationen, die Grössen, welche zur Berechnung der Dichte des festen Stoffes ($D^{4°}_{25.00°}$) erfordurt wurden.

C. *Die Herstellung und Messung von Kristallen verschiedener Dimension.*

1. *Kleine Kristalle.*

4. Nachdem das Dilatometer in der oben beschriebenen Art und Weise mit heiss gesättigter Lösung gefüllt war, erzielten wir die Bildung sehr kleiner Kristalle durch Abschrecken der Lösung in kaltem Wasser. Die Dimension der so gebildeten Kristalle ermittelten wir durch Ausmessen derselben unter dem Mikroskop[1]) (20 Messungen). Während die geringste Dicke 0.01 mm betrug, war die grösste 0.11 mm. Als Mittelwert fanden wir 0.05 mm. Es ergab sich ferner, dass die Kristalle nicht von Mutterlauge durchsetzt waren, sondern massiv und sehr spröde. Bei leiser Berührung zerfielen die Nadeln, welche ursprünglich etwa zehn Mal so lang als breit waren, in unzähliche Teilchen.

Die mit dem so hergestellten Material erhaltenen Werte sind in Tabelle 1 zusammengestellt. Die Bedeutung der Buchstaben ist in unserer vierten Mitteilung angegeben.

TABELLE 1.

Dichte der Salizylsäure bei 25.00° C.

Mittlere Dicke der Kristallnadeln 0.05 mm.

Versuchsnummer	m_1	$m_2 - m_1$	100 c	V	d	D
1	1.5333	20 0826	0.2144	21.2111	0.99765	1.4356
2	1.4129	20.1452	0.2145	21.1918	0.99765	1.4330
3	1.2414	20.1552	0.2147	21.0822	0.99765	1.4330
4	1.3020	20.2352	0.2150	21.2042	0.99765	1.4339

Mittelwert $D^{4°}_{25.00°} = 1.4339 \pm 0.0017$

5. Zu dieser Tabelle bemerken wir, dass sich der grösste Versuchsfehler in d zu ± 0.00002, in 100 c zu ± 0.0015 und in D zu ± 0.0015 berechnet.

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[1]) Vergl. unsere vierte Mitteilung § 3.

2. *Grössere Kristalle.*

6. Zur Darstellung grösserer Kristalle verfuhren wir folgendermassen. Nachdem das Dilatometer mit heisser, gesättigter Lösung gefüllt war (vergl. § 3), verschlossen wir den Trichter *A* mittels eines Gummipfropfens und hielten den Apparat in einem Glyzerinbad von etwa 100° C. Mittels eines darunter gestellten Mikrobrenners war es möglich die Abkühlung des Bades (besonders zu Anfang) äusserst langsam stattfindenzulassen, wobei ein in das Bad getauchtes Thermometer uns in Stand setzte die Temperatur fortwährend zu kontrollieren. So bildeten sich im Versuche 5 (Tabelle 2) aus der nur schwach übersättigten Lösung im Laufe von 24 Std. grössere Kristalle, deren Dicke zwischen 0.2 und 1.0 mm (8 Messungen) lag, im Mittel aber 0.6 mm betrug, während in den Versuchen 6 und 7 (Tabelle 2) die Dicke der Nadeln (8 Messungen) 0.6 bis 1.1 mm, im Mittel 0.8 mm war.

Wir bemerken, dass während die Kristalle von 0.8 mm im Mittel etwa 15 Mal so dick waren als die kleinen Nadeln von 0.05 mm, das Verhältnis zwischen den äussersten Werten der Dicke der untersuchten Kristalle mehr als 100 betrug.

7. Unsere Tabelle 2 enthält die Ergebnisse der Messungen, wobei das in § 5 mitgeteilte über den grössten Versuchsfehler jeder Einzelbestimmung gilt.

TABELLE 2.
Dichte der Salizylsäure bei 25.00° C.
Mittlere Dicke der Kristallnadeln 0.6—0.8 mm.

Versuchsnummer	m_1	m_2-m_1	100 c	V	d	D
5	1.3581	20.0698	0.2163	21.0770	0.99766	1.4343
6	1.3943	20.0832	0.2149	21.1154	0.99766	1.4346
7	1.3439	20.1514	0.2157	21.1497	0.99764	1.4337

Mittelwert $D^{4°}_{25.00°} = 1.4342 \pm 0.0005$

Es liegt hier also eine völlige Übereinstimmung mit den Werten von $D^{4°}_{25.00°}$ aus Tabelle 1 vor.

8. Nebenbei sei bemerkt, dass den in der Literatur vorhandenen Werten für *D* (nach Fr. Rüdorff 1) 1.442, nach H. Schröder 2) 1.483, nach A. Colson 3) 1.437) keine Bedeutung zukommt, da dieselben nach nicht

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1) Ber. **12**, 251 (1879).
2) Ber. **12**, 1611 (1879).
3) Bull. Soc. Chim. **46**, 3 (1886).

genau angegebenen Verfahren und unter nicht genau beschriebenen Verhältnissen ermittelt wurden.

ZUSAMMENFASSUNG.

Es wurde nachgewiesen, dass Salizylsäurekristalle von etwa 0.01 mm Dicke (bei 25.00° C.) dieselbe Dichte aufweisen, wie solche deren entsprechende Dimension 1.0 mm beträgt. Innerhalb der Versuchsfehler ist $D^{4^\circ}_{25\,00^\circ} = \mathbf{1.4340}$.

VAN 'T HOFF-*Laboratorium.*

Utrecht, Okt. 1935.

Chemistry. — *An osmotic complex with two stationary liquids.* By F. A. H. SCHREINEMAKERS and J. P. WERRE.

(Communicated at the meeting of October 26, 1935).

§ 1. *Introduction* [1].

First we take an osmotic complex.

$$inv.\, i_1 \,|\, L\,(z) \,|\, inv.\, i_2 \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

with the invariant liquids i_1 and i_2 and one variable liquid z only. If we leave this complex alone, it will depend upon different factors whether it will pass into an osmotic equilibrium, a stationary or another state.

We now assume that the variable liquid z has a given constant pressure P_c and that it contains only substances, which may diffuse through both membranes. We shall represent the stationary state into which (1) then may pass, by

$$\begin{array}{r|l|l} inv.\, i_1 & m \times stat.\, L\,(s) & inv.\, i_2 \\ & P_c \text{ given } \triangle m \leqq 0 & \\ \multicolumn{1}{r}{\longleftrightarrow} & & \multicolumn{1}{l}{\longleftrightarrow} \end{array} \quad . \; . \; . \; . \; . \; . \; . \; . \quad (2)$$

in which the stat. liq. s has a definite composition, which does not change any more during the rest of the osmosis. The signs ⟷ indicate that the osmosis is not over yet, but that each of the diffusing substances is still passing through both membranes; the diffusing quantities, however, have regulated themselves in such a way that the composition of liq. s does not change anymore. The quantity m of this liq. s, however, does change during the stat. osmosis; it may continuously increase or decrease, as has been indicated by $\triangle m \gtreqqless 0$. (For examples compare l.c.)

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[1] Comp. F. A. H. SCHREINEMAKERS, These Proceedings **34**, 78, 341, 524 and 823 (1931); **36**, 516, 717, 779 (1933).

F. A. H. SCHREINEMAKERS and J. P. WERRE, Rec. Trav. Chim. des Pays Bas **51**, 51, (1932),

J. P. WERRE, Dissertation, Leiden.

F. A. H. SCHREINEMAKERS and H. H. SCHREINEMACHERS, These Proceedings **35**, 1241 (1932); **36**, 629 (1933).

The composition of this stat. liq. is determined by:

a. the composition and the pressure of the inv. liqs. i_1 and i_2.

b. the nature of the two membranes and the ratio of their surfaces.

c. the given constant pressure P_c.

When the var. liq. z of complex (1) does not yet contain all the diffusing substances of the liqs. i_1 and i_2, they will be absorbed during the transition to the stat. state. (For examples comp. l.c.)

When the variable liquid z contains other diffusing substances besides those occurring in i_1 and i_2, they will disappear during the transition to the stationary state (comp. § 3).

During the osmosis the variable liquid proceeds along a path, ending always in points s, no matter what composition this liquid z may have at the beginning of the osmosis. If e.g. this liquid should have respectively the compositions a, b, c etc., it will proceed along the paths as, bs, cs etc. resp. (For examples comp. l.c.)

§ 2. *There are two stationary liquids.*

We now take an osmotic complex

$$inv.\ i_1 \,|\, L(z) \,|\, L'(u) \,|\, inv.\ i_2 \quad . \; . \; . \; . \; . \; . \; . \; . \quad (3)$$

with the two variable liquids z and u; again we assume that they have respectively a constant pressure P_c and $P'_{c'}$, which may of course be the same or differ from each other; further we assume again that z and u contain only substances which may diffuse through the three membranes. We now can represent the stationary state by:

$$\begin{array}{r|l|l|l} i_1 & m \times stat.\ L(s) & m' \times stat.\ L'(s') & i_2 \\ & P_c \text{ given } \triangle m \gtreqqless 0 & P'_{c'} \text{ given } \triangle m' \gtreqqless 0 & \\ \multicolumn{1}{r}{\longleftrightarrow} & \multicolumn{1}{r}{\longleftrightarrow} & \multicolumn{1}{r}{\longleftrightarrow} & \end{array} \quad . \; . \; . \quad (4)$$

in which each of the liquids s and s' will have a definite composition which does not change anymore during the rest of the osmosis. The signs ⟷ also indicate here that each of the diffusing substances is still passing through each of the three membranes, so that the osmosis is going on all the time.

As has been indicated by $\triangle m \gtreqless 0$ and $\triangle m' \gtreqless 0$ the quantities m and m' of the stat. liquid do change during this stationary osmosis.

The composition of the stationary liquids s and s' is defined by the same factors a, b and c (§ 1); in b "both membranes" must now be replaced, however, by "the three membranes" and in c the two pressures P_c und $P'_{c'}$ are found. During the osmosis each of the variable liquids z and u will proceed along paths, ending respectively in the points s and s'. The composition, these liquids z and u may have at the beginning of the osmosis, is of no account here.

§ 3. *An osmotic complex of $NaCl + Na_2CO_3 + H_2O$ with two stationary liquids.*

In the osmotic complex

$$i_1\,(W)\,|\,L\,(z)\,|\,L'\,(u)\,|\,i_2\,(20.32\,\%\,NaCl) \quad . \quad . \quad . \quad . \quad . \quad (5)$$

with three membranes of pig's bladder the inv. liquid i_1 consisted of pure water and the inv. liq. i_2 had the composition

$$20.32\,\%\,NaCl + 79.68\,\%\,W.$$

During the osmosis the inv. and the var. liquids were under a pressure of one atmosphere.

When the liquids z and u contain other diffusing substances (e.g. Na_2CO_3) besides $NaCl + W$, they will be absorbed and carried away in the course of the osmosis by i_1 and i_2; (5) then passes into a stat. complex

$$\begin{array}{l|l|l|l} inv.\ i_1 & stat. & stat. & inv.\ i_2 \\ (water) & L\,(s) & L'\,(s') & (20.32\,\%\,NaCl) \end{array} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

in which the stat. liquids s and s' contain $NaCl + W$ only.

1. At the beginning of the osmosis we gave the same composition to the liquids z and u, viz.

$$9.89\,\%\,NaCl + 7.09\,\%\,Na_2\,CO_3 + 83.02\,\%\,W \quad . \quad . \quad . \quad (7)$$

If we put $NaCl = X$ and $Na_2CO_3 = Y$ then we may imagine these liquids z and u represented by point a in the schematical fig. 1 and the liquids i_1 and i_2 by the points W and i_2.

It now appeared that during the osmosis liq. z proceeded along a path as and liq. u along a path as' (fig. 1).

We can draw these paths accurately with the aid of table 1. In column 1 we find the number of the determinations, in column 2 the time in days, passed after the beginning of the osmosis; in columns 3 and 4 we find the composition of the variable liquid z and in 5 and 6 the composition of the variable liquid u.

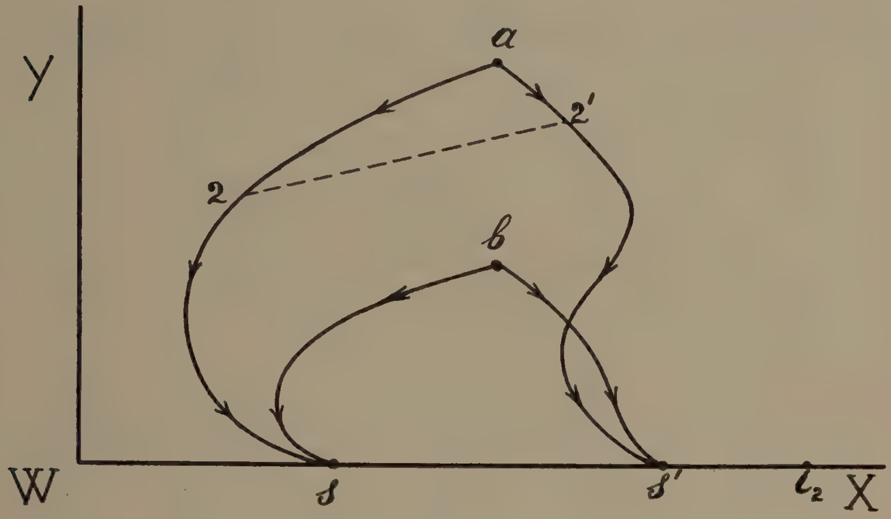

Fig. 1

It appears from this table that after 36 days z and u had got respectively the compositions,

$$6.38\,\%\ NaCl + 0.05\,\%\ Na_2\,CO_3 + 93.57\,\%\ W \quad . \quad . \quad . \quad (8)$$

$$13.37\,\%\ NaCl + 0.09\,\%\ Na_2\,CO_3 + 86.54\,\%\ W \quad . \quad . \quad . \quad (9)$$

As the two liquids had been changing their compositions only very slowly during the last 10 days and as the Na_2CO_3 had almost disappeared already, we may assume that the liquids z and u have almost reached the stationary points s and s'.

It appears from table 1 and the shape of the paths *as* and *as'* that during the osmosis the $NaCl$-amount of liquid z passes through a minimum and that of liquid u first through a maximum and afterwards through a minimum.

If we call 2 liquids, present in an osmotic complex at the same moment, conjugated liquids, then a definite liquid of path *as'* is conjugated with each liquid of path *as* and reversally; e.g. liq. 2 with 2' (viz. N⁰. 2 of table 1). As it appears from table 1 that liq. z always has a smaller Na_2CO_3-amount than liq. u, all conjugation-lines will incline towards the left. (comp. 2, 2')

TABLE 1

No.	t in days	Comp. of $L(z)$		Comp. of $L(u)$	
		% Na Cl	% Na_2CO_3	% Na Cl	% Na_2CO_3
1		9.89	7.09	9.89	7.09
2	2	5.58	5.00	10.99	5.99
3	4	4.24	3.55	11.74	4.65
4	6	3.93	2.31	11.99	3.54
5	8	4.28	1.64	11.21	2.83
6	10	4.39	1.23	10.92	2.26
7	12	4.68	0.95	11.06	1.72
8	16	5.33	0.54	12.05	0.94
9	20	5.96	0.31	12.70	0.50
10	26	6.18	0.13	13.09	0.20
11	36	6.38	0.05	13.37	0.09

2. For a new series of determinations the composition

$$9.92\ \%\ NaCl + 4.16\ \%\ Na_2\,CO_3 + 85.92\ \%\ W \quad . \quad . \quad . \quad (10)$$

was given to the two liquids z and u at the beginning of the osmosis; in fig. 1 this is represented by point b. It now appeared that during the osmosis liquid z proceeded along path bs and liquid u along path bs'; these paths can be drawn accurately with the aid of table 2, arranged in the same way as table 1.

It appears from the table that after 27 days the liquids z and u had obtained respectively the compositions

$$6.84\ \%\ NaCl + 0.02\ \%\ Na_2\,CO_3 + 93.14\ \%\ W \quad . \quad . \quad . \quad (11)$$

$$14.05\ \%\ NaCl + 0.03\ \%\ Na_2\,CO_3 + 85.92\ \%\ W \quad . \quad . \quad . \quad (12)$$

It appears from table 2 and the shape of the paths bs and bs' that the $NaCl$-amount of liquid z once more passes through a minimum during the osmosis; path bs', however, followed by liquid u, shows neither a maximum nor a minimum any more, but does show a point of inflection.

3. It appears from (8), (9), (11) and (12) and the determinations (14) and (15) to be discussed later on, that the stationary liquids s and s'

TABLE 2

No.	t in days	Comp. of $L(z)$		Comp. of $L(u)$	
		% NaCl	% Na_2CO_3	% NaCl	% Na_2CO_3
1		9.92	4.16	9.92	4.16
2	2	5.67	2.55	12.18	2.99
3	4	5.12	1.63	12.47	2.13
4	6	5.33	1.09	12.65	1.50
5	10	5.94	0.53	12.97	0.75
6	16	6.28	0.19	13.50	0.27
7	27	6.84	0.01	14.05	0.03

contain approximately ± 7 % and ± 14.1 % of $NaCl$ and of course no Na_2CO_3. We now represent this stat. state by:

$$\begin{array}{ccccccc}
inv.\ i_1 & \big| & m \times stat.\ (7) & \big| & m' \times stat.\ (14{,}1) & \big| & inv.\ i_2 \\
(W) & \big| & \triangle m < 0 & \big| & \triangle m' > 0 & \big| & (20.32) \\
 & \rightarrow W & & \rightarrow W & & \rightarrow W & \\
 & \leftarrow NaCl & & \leftarrow NaCl & & \leftarrow NaCl &
\end{array} \qquad \ldots \quad (13)$$

in which the numbers indicate the procents of $NaCl$. It appears from the determinations that the quantity of the left stat. liquid decreased ($\triangle m < 0$) and that of the right liquid increased ($\triangle m' > 0$). Through each of the three membranes a W-current flows and a $NaCl$-current; if we pay attention to $\triangle m < 0$ and $\triangle m' > 0$, it appears that the strongest water-current and the weakest $NaCl$-current pass through the central membrane.

4. When a complex contains one variable liquid only, this liquid will, during the transition towards the stationary state proceed along a path, the shape of which does not depend on the quantity of the liquid; this quantity namely influences only the velocity with which the liquid proceeds along that path.

In a complex with 2 (or more) variable liquids the shape of the path does depend upon the quantity of each of the var. liquids. In a complex with one var. liq. only it is situated between the inv. liquids i_1 and i_2; in complex (3) z is situated between i_1 and u, and u is situated between z and i_2.

As z is situated between i_1 and u, the change of z therefore will depend at any time upon the composition of u, which changes at a quicker or a slower rate, in accordance with the quantity being smaller or greater. The same rate obtains for liquid u, situated between z and i_2. From the above follows that the shape of the paths of liqs. z and u will depend on the quantities of this liquid. The final state of the complex (viz. the composition of the stat. liquids *s* and *s'*, the direction in which the substances pass through the membranes during the osmosis, etc.) does not depend on these quantities of course.

In order to prove this, the paths starting from point *a* (fig. 1) were determined once more, but with other quantities of the liquids *z* and *u*. It appears from table 3 that the liquids *z* and *u* had after 29 days got resp. the compositions:

$$6.54\ ^0/_0\ NaCl + 0.03\ ^0/_0\ Na_2CO_3 + 93.43\ ^0/_0\ W \quad . \quad . \quad . \quad (14)$$

$$13.69\ ^0/_0\ NaCl + 0.06\ ^0/_0\ Na_2CO_3 + 86.25\ ^0/_0\ W \quad . \quad . \quad . \quad (15)$$

If we draw these paths in fig. 1 with the aid of table 3, we see that they are situated quite differently from the paths drawn already.

TABLE 3

No.	*t* in days	Comp. of *L* (*z*)		Comp. of *L* (*u*)	
		$^0/_0$ Na Cl	$^0/_0$ Na_2CO_3	$^0/_0$ Na Cl	$^0/_0$ Na_2CO_3
1		9.87	7.09	9.87	7.09
2	2	5.14	4.10	11.33	5.00
3	4	4.37	2.60	11.69	3.63
4	6	4.44	1.75	11.98	2.63
5	8	4.77	1.21	11.74	1.91
6	10	5.01	0.84	12.17	1.33
7	14	5.62	0.43	12.65	0.65
8	20	6.05	0.15	13.20	0.23
9	29	6.54	0.03	13.69	0.06

We then see that the *NaCl*-amount of liquid *z* once more passes through a minimum indeed, but that this new path *as* is situated entirely within the concave side of the first. The *NaCl*-amount of liquid *u* passes through a maximum and minimum indeed which are only faintly marked however; the new path *as'* intersects the first in a point between the maximum and minimum.

Schaarsbergen (near Arnhem).

Leiden, Lab. of Inorg. Chemistry.

Anatomy. — *The degree of the changes in the cephalic index correlated with age and environment.* By C. U. ARIËNS KAPPERS.

(Communicated at the meeting of October 26, 1935).

In a preceding paper I called the attention to the frequent occurrence of the 78(79)—81 and 83—86 peaks in the cephalic index curves of Asiatic population groups north of the Himalaya and north of the 40th parallel in Europe[1]). In a second paper[2]) it was suggested that, although an approximately equal height of all four peaks in one group is very rare in Asia as well as in Europe, yet their not rarely combined occurrence seems to suggest that the groups showing the meso-subbrachycephalic peaks and those showing the brachyhyperbrachycephalic peaks might be related at their roots and that the 79—81 and 83—86 peak groups may be two different offshoots of an originally meso-subbrachycephalic Eurasian stem that by special circumstances, of endocrine and nutritive character probably, has differentiated into two branches.

For this supposition I found some support in the data recorded by BOAS[3]), GUTHE[4]) and HIRSCH[5]), from which it appeared that the American born sons of Russian Jews show an increase of the 79—81 or paleo-Asiatic peaks, even in the adult, at the expense of the 83—86 Central-Asiatic[6]) peaks, in comparison to the foreign born sons of the same parents (BOAS) or in comparison to their fathers (GUTHE).

Since this was published I had the honour to meet Prof. BOAS and to receive from him all the measurements relating to his work on American immigrants of various origin, Sicilians, Central Italians, Russian Jews, Bohemians, Hungarians, Slovakians, Poles and some relating to Scottish immigrants, alltogether about 14600 individuals[1]). I have used this material for studying the predilections in the changes with age and under the special circumstances, connected with immigration. For the changes correlated with age I also used the individual data published by F. REUTER, PEARSON and TIPPETT, GRÜTZNER, FRETS and others.

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[1]) The Central-Asiatic barrier and the distribution and associated occurrence of cephalic index peaks in Asiatic-European races. These proceedings, Vol. **37**, 1934.

[2]) Stability and variability of Central and paleo-Asiatic index peaks and some remarks on the Greenland Eskimo. These Proceedings, Vol. 38, 1935.

[3]) FR. BOAS. Abstract of report on changes in bodily form of descendants of immigrants. Government printing offices. Washington D.C. 1911. The same American Anthropologist, Vol. **1**, and Kultur und Rasse, Leipzig, 1914.

[4]) Notes on the cephalic index of Russian Jews in Boston. Am. Journ. of phys. Anthrop., Vol. **1**, 1918.

[5]) HIRSCH. Researches on the cephalic index of American born children of three groups. Ibidem, Vol. **10**, 1927.

[6]) Since it is probable that the so-called Central-Asiatic index type, although ontogenetically earlier, with adults is a phylogenetically later feature, it might be better to oppose this index type to the paleo-Asiatic type as neo-Asiatic. This would have also the advantage that the adjective Central-Asiatic — which does not at all indicate its spread — is done away with.

For the study of the predilection of certain indices in different age groups of various races, WELCKER's[2]), LANDSBERGER's[3]), BONNIFAY's[4]), RANKE's[5]) and RÖSE's[6]) papers do not contain enough individual data. Working on the dolicho- and mesocephalic skulls from Halle a/S, WELCKER found with the male skulls an increase of the l/br. index from birth to the end of the 1st year from 75—76.4. After this the increase continued and at the age of 20 years he noted an index of 80.4. His female skulls did not show such a gradually increasing index, the female indices of various ages exhibiting a good deal of irregularity, although some increase from the 2nd to the 14th year is noted. LANDSBERGER, BONNIFAY, RANKE and RÖSE expressed the results of their large material in averages only. BONNIFAY examining 1093 individuals of the largely brachycephalic population from the surroundings of Marseilles from birth to the age of 24 years, found an increase of the index from the second month (78, 20) to the end of the second year (83, 95) and after this a decrease to 82.42 at the age of 22—24 years. RANKE, (l.c. p. 174), working on 2509 children of the largely brachycephalic population[7]) of the German Holstein province, stated an increase of the male cephalic index from birth (81.5) to the second year (82.5). Here also this increase was followed by a gradual decrease, so that on the fifteenth year the index is again 81.5. Similarly his girls showed an increase in the first two years from 80.7 to 84.7 and after this a decrease to 81.3 in the 14th years[8]).

RÖSE's researches on boys and girls of 6—14 years of various districts of Germany and neighbouring countries (see spec. his part 1, p. 718 ff.) were specially intended to find the differences in length and breadth of the skull in both sexes. The arrangement of his enormous material (41086 cheldren) does not, however, allow a conclusion concerning the distribution of special index numbers in each year of both sexes in the various districts and countries examined.

FREEMAN[9]) does not give individual data but the averages of his large American material show a decrease of the index starting with boys before the 2nd year (82—81) to 79—78 on their 14th year. The same is seen with his girls. Curiously also here both groups again show a slight increase in their 15th year (see footnote 8).

In the paper by PEARSON and TIPPETT: "On stability o fthe cephalic indices within the race", Biometrika Vol. 16, 1924, p. 118, a great number of individual data concerning

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[1]) FRANZ BOAS. Materials for the study of inheritance in man: Columbia University Contributions to Anthropology, Vol. **6**, 1928.

[2]) WELCKER. Untersuchungen über Wachstum und Bau des menschlichen Schädels, Teil **1**, Leipzig, 1862.

[3]) Das Wachstum im Alter der Schulpflicht Arch. f. Anthrop., Bnd. **17**, 1888, p. 229.

[4]) BONNIFAY. Du développement de la tête au point de vue de la céphalométrie depuis la naissance jusqu'à l'âge adulte. Thèse de Lyon, 1897.

[5]) RANKE, O. Beiträge zur Frage des kindlichen Wachstums. Arch. f. Anthropologie, Bnd. **31**, 1905.

[6]) RÖSE. Beiträge zur Europäischen Rassenkunde etc. Arch. f. Rassen- und Gesellschaftsbiologie, Bnd. II, 1905 und Bnd. III, 1906.

[7]) For the population of this region see also: KEITER, Schwansen und die Schlei. Schleswigsche Bauern und Fischer, Jena, Gustav Fischer, 1931.

[8]) His 15th year female group again had a higher index.

[9]) FREEMAN (R. G.), Skeletentwicklung und Wachstum im Alter von 2—18 Monaten, von 2—7½ Jahren und von 8—14½ Jahren Anthropolog. Anzeiger Jhrg **10**, 1933, p. 185.

English individuals of various ages of both sexes occur. Their data concerning the children below 10 years, however, are not very numerous. I shall refer to them later on[1].

In my latest paper I already said something about GUTHE's and HIRSCH' work.

Referring for a discussion of GUTHE's work on Russian Jews to his curves added to my last paper, here I shall first compare the results of BOAS' and HIRSCH' work on Russian Jews. For the study of this material I again use the method of frequency curves, the only method that gives an insight into the question of predilection.

In the thick contin. line of the adjoining textfigure I plotted the American born Russian Jewish sons measured by HIRSCH. As these sons ranged from 6 to 16 years, I selected the American born Jewish sons of the same ages from BOAS' American born Russian Jews (crossed curve) and the same ages of his foreign (Russian) born Jewish sons (combed curve), so that the data might be comparable as far as age is concerned[2].

Furthermore in the thin continuous line I added the frequency curve of the cephalic indices of all the Russian born Jewish fathers of BOAS[3] and in the double continuous line the indices of the Russian born Jewish fathers of his American sons of 6—16 years only. As may be expected the fathers of BOAS' American born sons practically have the same indices as all the Jewish fathers immigrated into America, in so far as with both paternal groups the chief peak is at 82.

With BOAS' American born sons of 6—16 years we find three peaks, the middle one, the modulus of the curve, being also at 82. Of the two additional peaks one is less brachycephalic (80), the other more brachycephalic (84), this peak being also slightly indicated in their fathers.

Besides, with these sons there is a steep rise of the curve at 86, failing with their fathers. As will be confirmed below, the elevation at 86 is to be correlated with the age of these boys[4].

Turning to the combed curve of BOAS' Russian born sons of the same age group we find that the number of 86 indices is somewhat higher than with his American born boys, although the number of foreign born sons measured (353) is considerably smaller than the number of American born sons (538). Contrary to the curve of his American born sons the curve of his Russian born sons only shows one peak, viz. at 84, corresponding with the most brachycephalic one of the three American born peaks.

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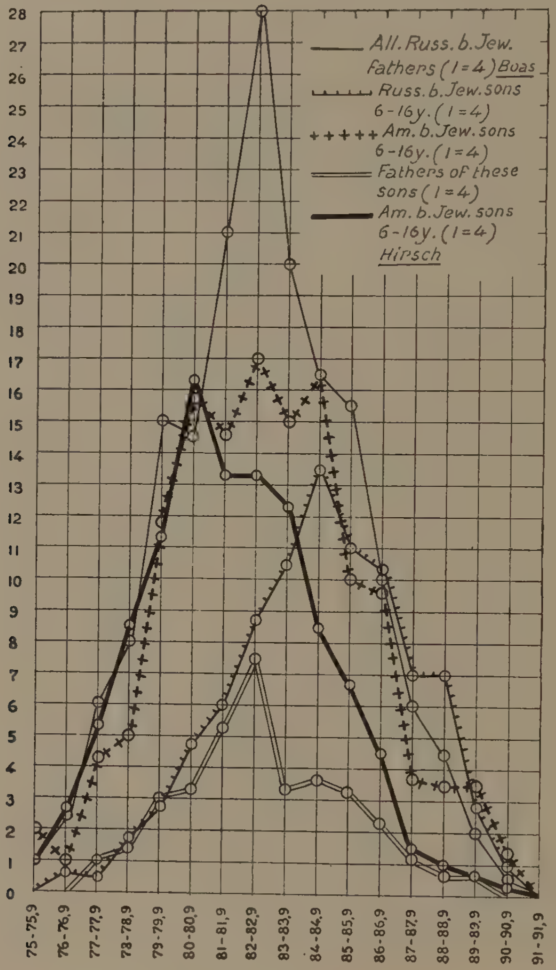
[1] For what reason these authors criticized Prof. BOAS' work so positively, even without reexamining his extensive material, is not clear from this paper. In my opinion BOAS' work is a masterpiece that cannot be done away with so easily.

[2] The amount of material in each case is large enough to give a reliable picture of the relations, each point in these curves standing for four individuals. The number of HIRSCH' American born boys is 428, of BOAS' American born boys 538, and of BOAS' foreign born boys 353.

[3] In HIRSCH' paper data concerning the parents of his boys do not occur.

[4] That BOAS' foreign born sons keep the infantile indices longer than his American born sons also appears from a comparison of the higher age individuals of these groups, the American born 10 years and more groups having only one peak at 81—82, the foreign born two peaks at 82 and 84. This may be explained hy tbe fact that the sons born before the immigration of their parents are probably brought up in the most unfavourable conditions, so that this phenomenon may be considered as a growth inhibition. This supposition is supported by the lesser stature of these children compared with the American born ones (see BOAS: l.c. 1911, p. 38 and 43).



Since the greater degree of brachycephaly with this race is an expression of a longer persistence of a childish skull shape, it appears from these curves that BOAS' foreign born Jewish boys are backward in development compared with his American born boys of the same ages1).

Comparing HIRSCH' American born sons with BOAS' we find that with

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1) See also KLEIN's paper in this issue of the Proceedings on the degree of the developmental changes of the length-breadth index of the head of Dutch Askenasim Jews.

HIRSCH' sons the 84 elevation, still present in BOAS' American born sons, fails and that the 82 index only gives a slight elevation. The outstanding peak in his curve corresponds with BOAS' 80 peak. From this it results that a greater number of the American born boys measured by HIRSCH have attained the lowest (80) index peak than of BOAS' sons, a feature explained by HIRSCH by the longer American citizenship, i.e. the longer improvement of environmental circumstances for the parents of his boys, in connection with the point, advanced by BOAS, that the longer the parents are in America the more the brachycephaly of the children decreases.

The comparison of 6—16 years children, as expressed in my text figure, was due to my wish to give a visual comparison of the results of the abovementioned authors.

For the curves in fig. 1 and 2 of the adjoining table I used another, more instructive grouping, dividing the material into adults (fathers and mothers) and children below 10 years.

Fig. 1 of my table gives a comparison of all the immigrant Russian Jewish fathers (continuous line) with their American born (crossed line) and Russian born (combed line) sons below 10 years. Comparing this figure with my text figure, we see that the chief difference shown by the Russian born sons below 10 years with the same group of 6—16 years (indicated by the same combed line in my text figure) is that the 86 elevation is higher with the younger group of Table I in which the 86 index even gives an outstanding peak, thus confirming the infantile character of this index. The American born sons of this age group and the 6—16 years group of my text figure (both indicated by a crossed line) show an analogous difference, the 86 elevation (compared with the other peaks) being again relatively higher with the younger group in Table I, fig. 1. Besides, the 80 peak has not yet attained the height it has in the 6—16 years group of the text figure.

Turning to BOAS' Jewish females[1]) (fig. 2), we see an analogous contrast between the Russian born and American born daughters below 10 years as observed with the sons, the foreign born girls below 10 years retaining a very high 86 peak, failing with the American born ones of the same age group.

Besides, the foreign born daughters have an ultra-brachycephalic peak at 89—90, also failing with the American born ones.

I may refer here to what I said concerning this ultrabrachycephalic peak in the Armenian women measured by Prof. KRISCHNER and failing with CHANTRE's and my Armenian women. Apparently in KRISCHNER's material (nearly all adults) we had a standstill of infantile indicial relations probably due to the very unfavourable environmental endocrine circumstances of these Turkish fugitives. I referred to an analogous contrast between Tyrolese skulls measured by TAPPEINER and those measured by FRIZZI (these Proceedings, Vol. 37, Table III, fig. 2 and 4).

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[1]) The continuous line in this figure gives the indices of all the foreign born Jewish mothers, the combed line indicates the foreign born, the crossed line the American born daughters below 10 years.

For the rest fig. 2 shows that with both the foreign and American born Jewish daughters below 10 years, in addition to the maternal (i.e. adult) 82 peak, there still occurs an even slightly higher 84 peak (present also in the sons of that age), a phenomenon to be explained again by their age.

As with the Poles (fig. 3) recorded by BOAS, the children below 10 years were not numerous enough to deal with the males and females separately, I took both sexes together doing the same with the parents (continuous line). However since also the divisions of foreign and American born children would be too small, if taken apart, I grouped (in the combed line) the foreign born children below 10 years with the American born children of that age[1]), in order to get at least a sufficient number to show the influence of the age factor.

The differences between the children and adults of this group shows that in the individual development a Central-Asiatic index curve may, at least partially, revert to a paleo-Asiatic one.

Studying fig. 3 we find a typical Central-Asiatic index curve with the children below 10 years whereas the adult parental curve has a more paleo-Asiatic character. The children have an 83 and 86 peak and in addition a small hyperbrachycephalic elevation at 89—90[2]). With the adults the latter peak fails, similarly the 86 peak. The only peaks in the parental curves are the 83 and especially the paleo-Asiatic 81 peak, the latter having developed apparently at the expense of the more brachycephalic indices.

Analogous differences between children below 10 years and adults are observed with the Hungarians and Slovaks[3]) measured by BOAS (fig. 4), for whom I used the same grouping as with the Poles. Here also the children below 10 years (combed line fig. 4) have typical Central-Asiatic peaks at 83 and 86 and in addition show a high ultrabrachycephalic peak at 89[2]). With the adults (parents) the latter peak fails and the 86 peak, though still very outstanding, has relatively decreased in comparison with the 84 peak. Besides, a considerable paleo-Asiatic 82 peak occurs.

The decrease of the 86 index is also observed with the Pomeranian

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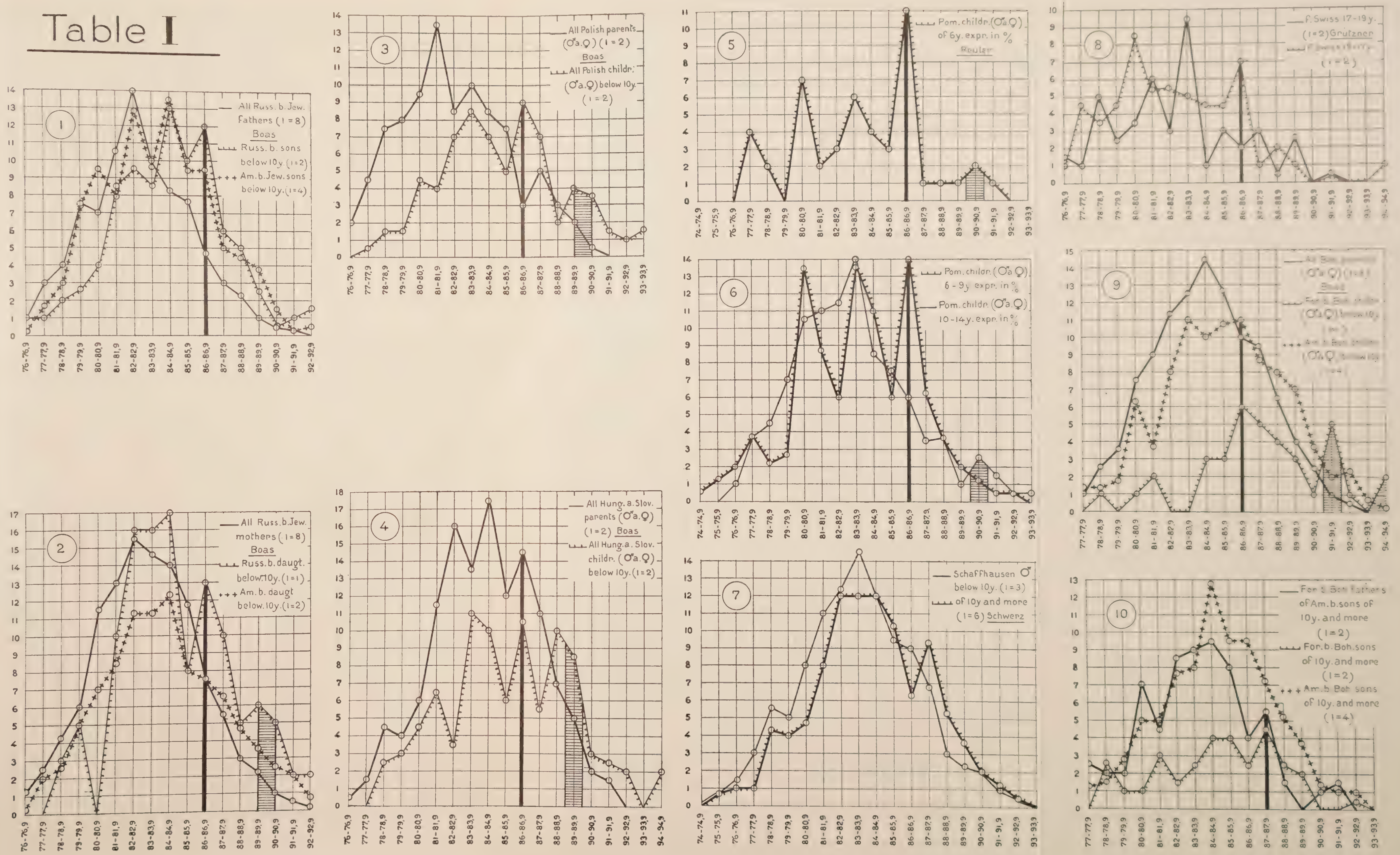
[1]) This grouping of the Polish and American born children is not so very misleading as the difference between these children in BOAS' material is not so striking as it is with the Jews.

[2]) In connection with my remark (these Proceedings, Vol. **37**, 1934, p. 606(7) that the hyperbrachycephalic peak specially occurs if the 86 peak is very high, it is interesting to note that the 86 peak is about as high as the 83 peak.

[3]) I may leave aside the question if the grouping together of Hungarians and Slovakians as done by BOAS is allowed. The point concerned here is the relationship between the indices of the children and those of their parents. For individual data of Hungarians only I refer to BARTUCZ' paper: "A mal magyarság "cephal-index" -éröl." in A Magyar Nemzeti Múzeum Néprajzi Osztályának ERTESITÖJE. Budapest 1912.

Table I


1
All Russ. b. Jew. Fathers (1 = 8) Boas
Russ. b. sons below 10y. (1=2)
Am. b. Jew. sons below 10y. (1=4)
2
All Russ. b. Jew. mothers (1=8) Boas
Russ. b. daugt. below 10y. (1=1)
Am. b. daugt below. 10y. (1=2)
3
All Polish parents (♂a.♀) (1=2) Boas
All Polish childr. (♂a.♀) below 10y. (1=2)
4
All Hung. a. Slov. parents (♂a.♀) (1=2) Boas
All Hung. a. Slov. childr. (♂a.♀) below 10y. (1=2)
5
Pom. childr. (♂a.♀) of 6y. expr. in % Reuter
6
Pom. childr. (♂a.♀) 6-9y expr. in %
Pom. childr. (♂a.♀) 10-14y. expr. in %
7
Schaffhausen ♂ below 10y. (1=3)
of 10y and more (1=6) Schwerz
8
f. Swiss 17-19y. (1=2) Grützner
(1=2)
9
For. b. Boh. fathers of Am. b. sons of 10y. and more (1=2)
For. b. Boh. sons of 10y. and more (1=2)
Am. b. Boh. sons of 10y. and more (1=4)
10
74-74,9
75-75,9
76-76,9
77-77,9
78-78,9
79-79,9
80-80,9
81-81,9
82-82,9
83-83,9
84-84,9
85-85,9
86-86,9
87-87,9
88-88,9
89-89,9
90-90,9
91-91,9
92-92,9
93-93,9
94-94,9

children examined by REUTER[1]). Though REUTER also combines the boys and girls in his curves, his data have the great advantage that his material is separated into three important age groups, viz. a group of 6 years, a group of 6—9 and a group of 10—14 years.

Looking at his curves (reproduced in fig. 5 and 6) we see that at the age of 6 years (fig. 5) three peaks occur, at 80, 83 and 86, the latter being by far the highest (22 % of the whole group). In his group of 6—9 years (combed line fig. 6) the 86 index, though still very outstanding, is represented by 14.5 % only, the 80 and 83 peaks having considerably increased, and nearly attaining the same height as the 86 peak. With the children of 10—14 years (continuous line fig. 6) the 86 peak has entirely disappeared[2]) and the 83 peak has considerable increased.

It is a curious difference between the Polish and Hungarians (with Slovakians) on the one hand and the Pomeranians on the other that with the first mentioned peoples the older (in casu adult) stages show a tendency of the subbrachycephalic indices (81 and 82) to increase, whereas the subbrachycephalic index (in casu 80) of the Pomeranians of 10—14 years does not show this increase, the percentage of 80 indices in REUTER's 10—14 years material being only 10.5 % against 13.5 % in the preceding group. This may be different with the adult Pomeranians, but unfortunately I could not find sufficient individual data of adult Pomeranians.

Analogous changes are observed if we compare SCHWERZ' data[3]) concerning the indices of the Schaffhausen boys below ten years and of 10 years and more (fig. 7). Also in this case the hyperbrachycephalic (in casu 87) index of the younger group looses its outstanding character in the older group while the 83 index increases.

The same conclusion may be drawn from Miss GRÜTZNER's data[4]) on Swiss girls from Zürich although this authors material only includes groups from 15 to 19 years. Fig. 8 shows that the 86 index, still very outstanding with her girls of 15 to 17 years (combed line), has practically disappeared in her girls of 17 to 19 years (continuous line) with whom the 83 index is by far the highest.[5])

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[1]) F. REUTER. Beiträge zur Anthropologie Hinterpommerns. Arch. f. Anthrop. Bnd. 28, 1903, p. 289.

[2]) The percentage of 86 indices is only 6 % in this age group.

[3]) F. SCHWERZ. Untersuchungen über das Wachstum des Menschen. Arch. f. Anthropologie. Bnd. 38, 1911, p. 1.

[4]) G. GRÜTZNER. Körperwachstum und Körperproportionen 15—19-jähriger Schweizerinnen. Dissertation Zürich, 1928.

[5]) The infantile character of the 86 (87) index also appears from ENGELSPERGER's researches on Munich boys and girls of 6 years, the most outstanding peak in this age with the boys being 86 with the girls 87. As however ENGELSPERGER did not examine children of higher ages the further fate of this index in the evolution of his material does not appear from his work. See his Dissertation, Zürich 1905: Beiträge zur Kenntnis der physischen und psychischen Natur des sechsjährigen in die Schule eintretenden Kindes.

The relations with BOAS' Bohemians more or less resemble those of the Pomeranians and Swiss.

Unfortunately BOAS' Bohemian material, though very numerous, does not contain enough foreign born Bohemian children below 10 years to deal separately with the boys and girls of this group. I therefore grouped both sexes of this age together in the combed curve of fig. 9. Although even then the number of individuals of this group is still small, the curve resulting from it evidently shows its highest elevation at 86. Besides, it has a pronounced ultrabrachycephalic elevation at 91 and some 94 indices. The typical adult (parental) 84 index is indicated in the foreign born children below 10 years only by a sudden rise of the combed curve.

With the American born children below 10 years (crossed line, fig. 9) the ultrabrachycephalic peak fails, the 86 peak is still indicated, but in addition there are a great many 83, 84 and 85 indices. Comparing these curves with that of the adults (parents: continuous line), we see that with the latter the number of 86 indices is relatively smaller, the 84 index being the only outstanding one.

Analogous differences are observed in comparing the foreign and American born Bohemian sons of 10 years and more (fig. 10). With the foreign born sons (combed line fig. 10) the highest peak is at 87, an almost equally high one at 84—85. With the American born sons of 10 years and more (crossed line in fig. 10) an outstanding 87 peak (though indicated in their Bohemian born fathers) fails, the main peak being at 84 which also with their fathers shows the highest elevation.

Leaving the prevailingly brachycephalic races I now shall deal with some prevailingly mesocephalic peoples (Table II), starting with the Dutch with whom there still is a distinct brachycephalic component.

With FRETS [1]) Dutch sons below 10 years (fig. 11, combed curve) only two peaks occur: a high 85 and a still higher 80(81) peak. With their fathers (continuous line) a 85 peak fails but is substituted (if that expression is allowed) by a lower Central-Asiatic peak (83). Besides, the paleo-Asiatic 80 peak has increased, and in addition a high mesocephalic peak (78) occurs with them.

Contrary to his males the females, measured by FRETS (fig. 12) hardly show any difference in the age groups. Both the girls below 10 years (combed curve) and their mothers (continuous line, fig. 12) have an 83 and an 80—81 peak; with the mothers the 83 peak is even slightly higher. On the other hand the typically Nordic 78 peak of the mothers is not indicated in the girls who, however, have a distinct 76 elevation to which I shall return later.

A comparison of both curves in fig. 12 shows that with the females the

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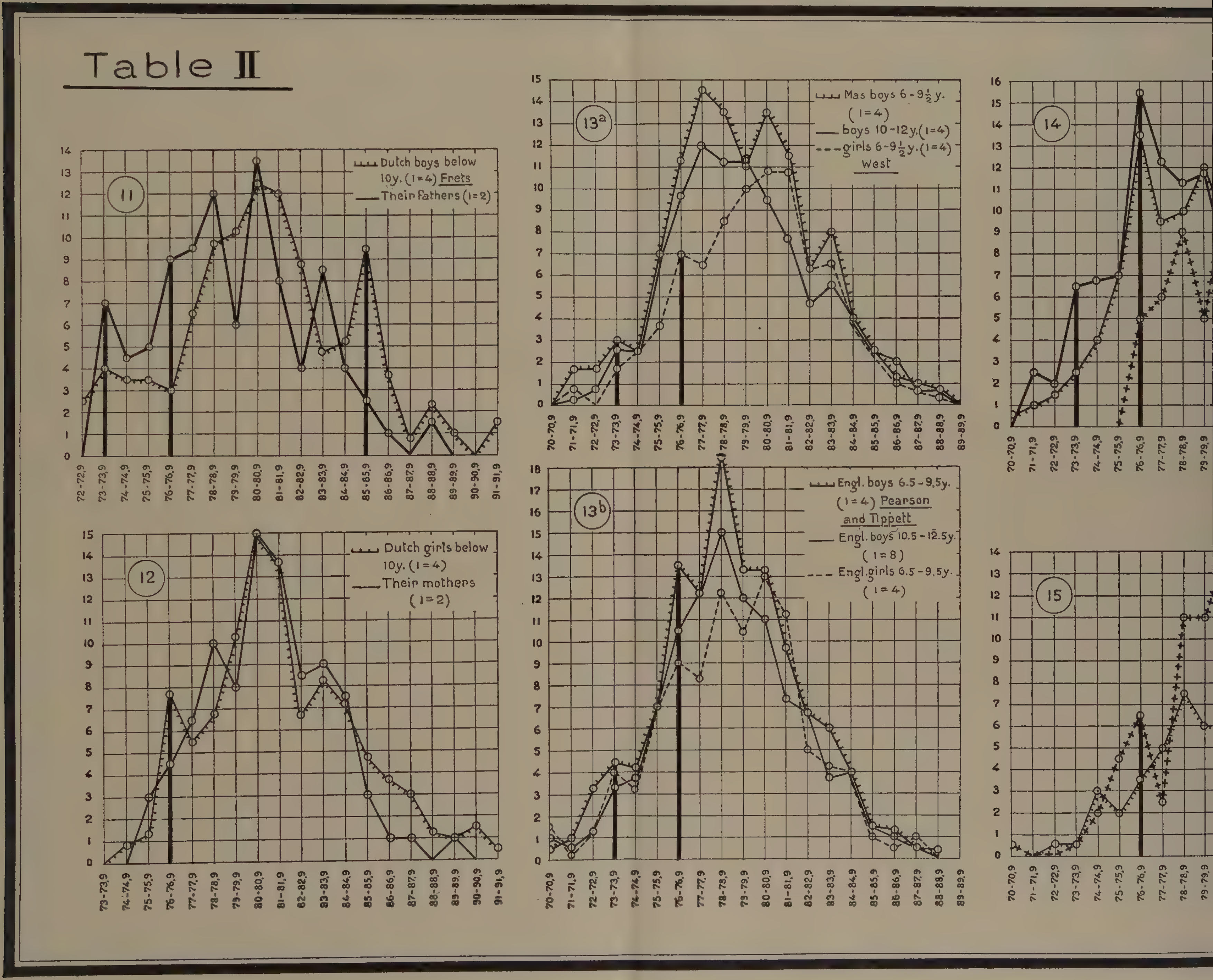
[1]) G. P. FRETS. Heredity of the head form in man. Genetica Vol. III, 1921, pp. 193—400, and G. P. FRETS, The heredity of the cephalic index. Dissertation Amsterdam. 1924. FRETS' material embraces more than 3600 individuals, of over 360 families.

C. U. ARIËNS KAPPERS: THE CHARACTER OF THE CHANGES IN THE CEPHALIC INDEX CORRELATED WITH AGE AND ENVIRONMENT.

Table II



difference between the adult and infantile relations is not so great as with the males or — in other words — that the infantile characteristics tend to persist more with females than with males.

It is interesting to observe that the mother and father curves resemble each other, both having an 83, 80 and 78 peak, the chief difference being that with the fathers the 78, with the mothers the 80(81) peak is relatively higher and that both Mediterranean elevations (73 and 76 [1])) are indicated with the fathers while the mothers only show the 76 elevation.

With the English children and with those of Massachussets (New-England) the relations are analogous to those of the Dutch. I shall first deal with WEST's data [2]) concerning Massachussets boys (fig. 13*a*) since with them, as with the Dutch, there still is a distinct 83 peak which, however, is more outstanding with the boys below 10 years than with those of 10, 11 and 12 years. The prevailing index of the latter is mesocephalic (77). With the boys below 10 years also a high 80 index occurs which in the girls of that age even is the only one, apart from a small 76 peak to which I shall return later.

With the English children the age changes in the cephalic index resemble those of the last two groups with this difference that an 83 peak fails here. In fig. 13*b* I give the frequency curves of the boys and girls of 6.5 to 9.5 years and of 10.5 to 12.5 years, made after the figures, recorded by PEARSON and TIPPETT (l.c. supra [3])).

In the boys of the 6.5—9.5 years group (combed line) as well as in the girls of this age (interrupted line) four peaks are seen, a 73, 76, 78 and 80 peak. The same four peaks were found with the Dutch. The correspondence of these English groups with the (adult) Dutch males and females also appears in this respect that with the boys the 78 peak is higher than with the girls and with the girls the 80 peak is higher than with the boys. The chief difference with the Dutch curves referred to is that with the Dutch fathers and females a distinct 83 peak occurs, an expression of the so-called Alpine constituent of our race, prevailing even in the province of Zeeland where both Central-Asiatic indices: 83 and 86 stand out very prominently (cf. BOLK, l.c. infra).

With the older: 10.5—12.5 years boys (continuous line, fig. 13b), and also with the girls of that age group, the Mediterranean indices, 73 and 76, are entirely blended by the higher indices. With the boys of this age group the 78 peak is the only one (with the girls of 10—12 years an additional

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[1]) As I shall show in my next paper, the 73 and 75(6) peaks are typical of the original Mediterranean race as it still prevails on the south coast of the Mediterranean and still is indicated on Sicily (figs. 14—18).

[2]) G. M. WEST. Anthropometrische Untersuchungen über die Schulkinder in Worcester, Mass., Amerika. Arch. f. Anthrop. Bnd. 22, 1894, p. 1.

[3]) I must call the attention to the slightly different arrangments of the index units in PEARSON's and TIPPET's paper (70, 45; 71, 45, etc.), abusively replaced by my customary division (70—70.9; 71—71.9, etc.).

80 peak remains). As stated above with both the English and the Dutch indications of a Mediterranean component are evident.

That the ancient Mediterranean 73 and 75—76 peaks still are typical of some Sicilian groups appears from the data published by BOAS and MONDIO that show that here still large groups occur which for the greater part do not belong to the Eurasian stocks, but are to be grouped together with the North-African races.

Nevertheless, although the oldest population of this island may have been entirely Mediterranean, the present population has been influenced by the same peoples who, coming from the North, invaded the northern shores of the Mediterranean, blending the more ancient population, a process so conspicuous at an early date already in Greece.

This explains that the indices of Sicilians recorded in literature show considerable differences. Whereas the indices of male Messinese skulls measured by MONDIO [1]) (dotted line, fig. 18) show peaks at 73 and 75, corresponding approximately with the cephalic 74 and 76 peaks, the cephalic indices of Sicilian soldiers recorded by LIVI [2]) (continuous line, fig. 18) show peaks at 79 and 81. The latter peaks are typically paleo-Asiatic and are probably due to later invasions of the island.

The indices of the majority of the Messinese skulls are nearer the indices of the original Mediterranean inhabitants (the eneolithic Sicilian skulls have their highest elevations at 72 and 76) [3]).

From the data recorded by BOAS (fig. 18, combed line) it appears that, although an additional 79 peak is not failing with his male Sicilians, yet the index curve of his adult male Sicilians born in Sicily (see also the frequency curve of his adult females: fig. 16, continuous line) shows its highest elevation at 76 and besides a steep elevation at 73.

A comparison with the North-African population [4]) confirms that the 73 and (75)76 indices indicate the ancient Mediterranean component of this people. In other words, BOAS' Sicilian material is more typically Mediterranean than LIVI's.

Proceeding to the Sicilian born and American born offspring of BOAS' Sicilian immigrants (figs. 14—17), I give in fig. 14 the curve of all his Sicilian born fathers migrated to America (continuous line), their Sicilian born sons of 10—20 years [5]) (combed line), and their American born sons of 10—20 years.

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[1]) MONDIO. Studio sopra duecento teschi Messinesi. Arch. per l'Antrop. e per l'Etnolog. Vol. 27, 1897.

[2]) LIVI. Antropometria militare. This book not being at my disposal, LIVI's figures are quoted from F. and H. BOAS: The head form of the Italians as influenced by Heredity and Environment. American Anthropologist. Vol. XV, 1913.

[3]) See our Introduction to the Anthropology of the Near East in ancient and recent times. Noord-Hollandsche Uitgeversmaatschappij, Amsterdam 1934, fig. 71 at the bottom.

[4]) See my following paper.

[5]) I have taken 20 years as the upper limit of this group to make it more comparable to the adult American born Sicilian sons, few of whom pass this age limit.

Evidently the first two curves run parallel, the only difference being that in addition to the Mediterranean 76 and the non-Mediterranean 79 peak occurring in both curves the Sicilian born sons of 10—20 years also have a Mediterranean 73 peak, failing with their fathers. The relations with the American born Sicilian sons are different. Studying the curve of the American born sons of 10—20 years (crossed line, fig. 14) we find that, although the 76 Mediterranean index is still indicated by a sudden elevation, their prevailing peaks are at 78 and 80.

That this is not occasionally so appears from fig. 15 showing that also the American born sons below 10 years have a low peak at 76 but much higher elevations at 78 and 80.

Apparently there is not much difference between the American born sons below 10 years and those between 10 and 20 years, which shows that the American born sons tend to keep their infantile indices, while the Sicilian born sons in growing up reduce their infantile indices in favor of the ancestral 76 index. This causes both American born groups to differ considerably from the Sicilian born fathers and also from the Sicilian born sons of 10—20 years by a decrease of the Mediterranean and an increase of the 78 and 80 indices. Only BOAS' Sicilian born sons below 10 years (not very numerous) show a close resemblance with the American born sons of the same age than with the Sicilian born sons of 10—20 years [1]).

With the females (fig. 16 and 17) we are struck by a difference between the Sicilian born mothers with their typical Mediterranean 76 and additional 80 peak, and their 10—20 years Sicilian born daughters with whom the 76 peak fails, and who still keep the infantile 78 peak, sharing with their mothers the smaller 80 peak only. It is certainly strange that, whereas the 76 and 79 peaks were almost equally outstanding with the Sicilian fathers and their Sicilian born sons of 10 to 20 years, the Sicilian born daughters of 10 to 20 years show such a difference with their mothers. This, however, shows the longer persistence of the infantile 78 index type with the females, mentioned above.

Comparing fig. 16 with fig. 17 we find again that (as with the American born sons) there is a remarkable constancy in the American born daughters below 10 years and between 10 and 20 years, which means that also the American born daughters keep their prevailing infantile index (80). It is interesting that, while the prevailing index persisting so long in the Sicilian born daughters is 78, the prevailing persisting index with the American born Sicilian daughters is 80.

While both age groups of the American and Sicilian born daughters [2]) confirm the longer persistance of the infantile type in the female sex, the prevailing index is higher in the American than in the Sicilian born daughters.

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[1]) If this appears to be a rule, it would mean that the 76 peak develops after 10 years chiefly.

[2]) That in the Sicilian born women the typically Mediterranean 76 peak develops at a later age than in the Sicilian born males is confirmed by the fact that even with BOAS' Sicilian born daughters of 20 years and more (dotted line, fig. 16) the highest peak (77) has not yet reached the 76 point.

It is furthermore evident that with the American born sons two indices stand out, the 80 and 78 index, the 80 index prevailing over the 78 one, the 80 peak being the only outstanding one in the American born daughters. Though the amount of adult American born Sicilians recorded in BOAS' publication of 1928 is not yet large enough to show that the 78—80 index type remains the prevailing one in the adults, the evolutional processes discussed show that the index curve of this people, at least in these groups, passes through or even approaches the paleo-Asiatic type.

This phenomenon might be explained in two ways. No group of a population is unmixed and not all of BOAS' Sicilians have a typically Mediterranean index. There are fathers with a paleo-Asiatic index (79) as well as mothers with a paleo-Asiatic index (80), even in BOAS' material, though not so many as among LIVI's soldiers. Now one explanation of the indices observed with BOAS' American offspring would be that the paleo-Asiatic index becomes dominant under favourable circumstances, even to such an extent as to blend almost entirely the Mediterranean index, still indicated by a peak at 76 in the American born sons and daughters below 10 years but by an elevation only with the American born sons and daughters between 10 and 20 years. This fact as well as the fact that even with the 10 to 20 years Sicilian born daughters a 76 peak does not yet occur pleads in favour of the recessive character of the Mediterranean index if the ancestry also contains paleo-Asiatic indices.

We may, however, also consider the developmental differences occurring with the Sicilians offspring under different environmental influences from an other view point. It may be that the prevalence of the 78 and 80 peaks is not an expression of domination in racial mixture. Just as the high adult indices 83—86 of Central-Asiatic groups may be a persistence of the infantile stages of their 78(79)—80(81) index ancestors, the adult 78 and 80 index may represent persistent infantile indices of the Mediterranean (73—76 index peak) component itself.

In other words, while the Eurasian races may *lose* their infantile brachycephalic and hyperbrachycephalik peaks in the course of evolution if this evolution is favoured by good circumstances, the Mediterranean race on the other hand may *keep* its infantile 78 and 80 index peaks if their further existence is favoured by good circumstances. In both cases the skull acquires its optimum condition as far as its contents are concerned.

BOLK [1]) measuring the capacity of 255 Dutch male and female skulls ranging from an index of 70—89, found the greatest capacity to occur with the 77 cranial (78 cephalic) index, and a smaller rise at an index of 82 (83). Also SCHWERZ [2]) found the greatest capacity with his mesocephalic not with his brachycephalic skulls. DIJKSTRA [1]), reexamining this problem with 124 skulls from Groningen (Holland), found the optimum capacity with males as well as with females at a cranial index of 78 and a second, much smaller rise of the capacity curve at 84.5.

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[1]) L. BOLK. Kraniologische Untersuchungen holländischer Schädel. Zeitschr. f. Morphologie und Anthropologie 1903, Bd. V.

[2]) SCHWERZ. Die Alamannen der Schweiz. Zeitschr. f. Morph. u. Anthrop. Bnd. **14**, 1912.

If the second supposition of an adult 78—80 index type as a favourable persistence of an infantile stage of the 73—75(76) index type, and the origin of the 83—86 index type as a less favourable infantile persistence of the 78(79)—80(81) type is right, it would help us to understand the origin of these three main types of index curves from the index type of one common stem, the reindeer race, with its prevailing 71—73 cranial (73—75 cephalic) index type, which nowadays is still prevailing in Africa as I shall show in a following paper.

Further researches will be necessary to decide if the latter supposition is supported by more facts. I only want to add that, although this supposition would fit in SERGI's conceptions of the origin of the Nordics from Mediterraneans [2]) it is no reason to follow him in doing away with the adult index, as one of the most characteristic features of racial differentiation.

I shall not enter here into a detailed discussion of BOAS' Central-Italian group. Especially the females of this group are a mixture that makes it very difficult to draw conclusions from it. On the whole, however, I believe that here also BOAS' conclusions are right.

I only wish to use his male material for showing again the influence of the age factor in this group, which (as far as the males are concerned) largely has a paleo-Asiatic index type, as E. SCHMIDT's Pompeians [3]) already had.

Fig. 19, table II, relating to Italian born Italians, shows that the sons below 10 years have their index peaks at 79, 81 and 83. With the sons of 10 years and more the (78)—79 and especially the 81 peak has increased and with the adults (their fathers) the 78—(79) index is by far the highest.

As with the Eurasian groups discussed before, also in this case the increase of the mesocephalic index with age goes at the expense of the brachycephalic, especially at the expense of the Central-Asiatic (83 and higher) indices (cf. also figs. 1—3 in KLEIN's paper, l.c. supra).

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[1]) DIJKSTRA. Bijdrage tot de physische anatomie van schedel en hersenen. Geneesk. Bladen uit Kliniek en Laboratorium. Serie XXV, N⁰. 6, 1927.

[2]) S. SERGI. The Mediterranean Race. London, 1901.

[3]) E. SCHMIDT. Die antiken Schädel Pompejis. Arch. f. Anthrop. Bnd. **15**, 1884. The curve of the male Pompeian skulls examined by SCHMIDT shows an outstanding 80 peak and additional 77 and 83 peaks, closely corresponding with the cephalic 81, 78 and 84 peaks of BOAS' Central Italian fathers.

Physics. — *Research on thin layers of tin and other metals.* I. *The influence of thin metal layers on the deterioration of technical insulating oils.* By P. J. HARINGHUIZEN and D. A. WAS. (Communicated by Prof. L. S. ORNSTEIN.)

(Communicated at the meeting of October 26, 1935).

Summary.

The influence of metals on the deterioration of insulating oils has been studied. It appeared that on both sludge formation and increase of acidity copper has the largest influence, lead less, and tin the least. In some cases tin may act as an anti-oxidant.

The character of the catalysis has also been a subject of investigation.

A fact known in technics is that the deterioration of insulating oil by oxidation in air is influenced by metals.

The aim of our investigation was to compare the action of tin, copper and lead; we used three transformer-oils of different nature, hereafter indicated by A, B and C.

As sludging and acid formation especially diminish their technical qualities, the influence on these phenomena has been measured.

Nature of the oils:

A forming much sludge, little acid
B ,, a little ,, much ,,
C ,, a little ,, little ,, (etherial acids)

Samples of these oils were deteriorated in glass basins (9 cm), by heating at 90° C. in an electrical furnace; for studying the action of the metals, glass pieces with thin metal layers were dipped into the oils. The metal layers were obtained by high vacuum evaporation [1]); their area was standardised at 5 cm^2.

Sludge formation.

Quantities of 50 c.c. of the oils were heated for 1000 hours and the quantity of sludge formed was measured by filtering through a B_2 crucible; the sludge being washed out with gasoline was dried at 90° C.

Table I gives the quantities of sludge in mgr. per 50 c.c. oil.

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[1]) See publication II of this series.

TABLE I.

Oil	*Sn*	*Pb*	*Cu*	Blank exp.
A	6.0	9.0	19.0	6.9
B	4.0	4.4	5.7	2.0
C	0	2.7	10.2	1.1

These figures show that copper gives the strongest increase in sludge formation, lead less and tin the least. The fact that the oils *A* and *C* in contact with tin formed even less sludge than in the blank experiment. shows that tin may perhaps act as an anti-oxidant; an analogous result has been found by MARDLES [1]) who studied the effect in lubricants.

The colour of the oils.

During the deterioration the oils become darker; now it appeared that after heating for 1000 hours the colours of the (filtered) oils have the same succession as the quantities of sludge.

In the case of oil *A* the authors have determined the colours quantitatively with the aid of the colorimeter constructed by WOUDA [2]).

The values of co-ordinates of the colour points obtained are given in Table II.

TABLE II.

	Original oil	*Sn*	*Pb*	*Cu*	Blank exp.
red	45.1	53.7	55.4	63.1	55.9
green	41.3	41.9	41.0	35.4	42.6
blue	13.4	4.5	3.6	1.4	1.5

From the figure obtained by plotting these values in the known colour triangle the effective wavelength and the saturation of the colour can be determined (see Table III).

TABLE III.

	Orig. oil	*Sn*	*Pb*	*Cu*	Blank exp.
eff. λ	5780	5840	5860	5960	5845
saturation	0.62	0.89	0.92	0.975	0.965

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[1]) E. W. J. MARDLES D. Sc., Techn. Publ. of the Int. Tin Research, Series C N⁰. 2.

[2]) J. WOUDA: Proc. of the Acad. of Amsterdam, Vol. XXXVIII, N⁰. 6, 1935.

From a comparison of this table and table I it can be seen that there is a parallelism between sludge formation and eff. λ.

The saturation of the colour forms an exception — "blank exp." being near *Cu* —. The conclusion from this result is that perhaps the increase of eff. λ, which will be caused by polymerisation in the oil, will be followed by sludge formation caused by higher polymerisation of the same complexes. This would explain the parallelism mentioned above.

Acid formation.

Quantities of 100 c.c. oil were heated and after every two hundred hours the acid value was measured according to the method given by the V. D. E.

It appeared that the oil *A* forms very little acid, and oil C only etherial acids; in both cases the increase of the acid value was less than the experimental error.

As is pointed out in an investigation on the corrosion of the thin layers (see publ. II of this series) the quantity of acid which is necessary for the corrosion of the metal can be neglected.

Fig. 1 shows the increase of the acid value in the case of oil *B* by deterioration under influence of the three metals.

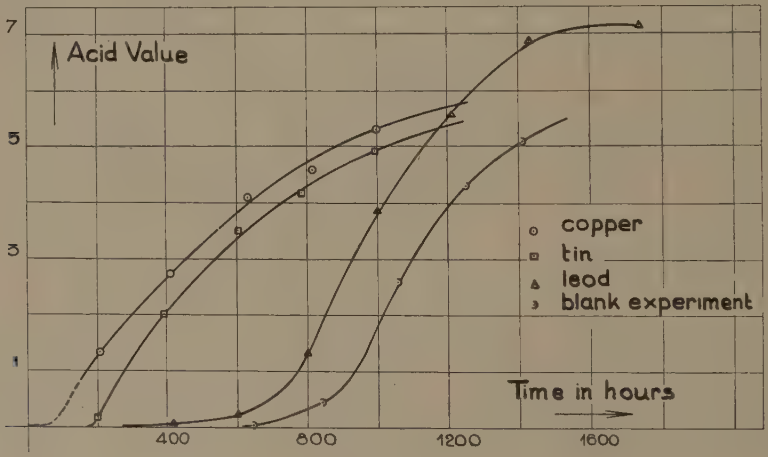

Fig. 1.

It appeared that the increase of acidity due to copper is the greatest; the curve due to tin begins at a later point, after some hundred hours it becomes parallel to that of the one copper. Although the lead curve starts much later, it is much steeper, so that after 1200 hours it even intersects the curves of tin and copper. Parallel to the lead curve runs that of the acid increase in the oil heated without metal.

We have observed a slight increase in acidity in a deteriorated oil, which was left at room temperature without contact with metal; the relative increase has been found independent of the metal used (see table IV).

TABLE IV.

	Sn	*Cu*	*Pb*
acid value deter. oil	4.94	5.31	1.34
„ „ after 5 weeks room t.	5.28	5.67	1.43
relative increase in %	6.9	6.8	6.7

The character of the catalytic action of metals on oil deterioration.

In order to investigate this character, the following experiments were made:

The acid curve due to copper was measured on three samples of oil *B*. Into each sample an equal copper layer was dipped; the first was taken out after 30 hours, the second after 100 and the third after 450 hours.

In the case of a heterogeneous catalytic action, there must be a great difference between each of the three curves; for after removing the metal surface the catalytic action will be stopped.

In the case of a homogeneous action the removing will not influence the curve, if enough copper is dissolved.

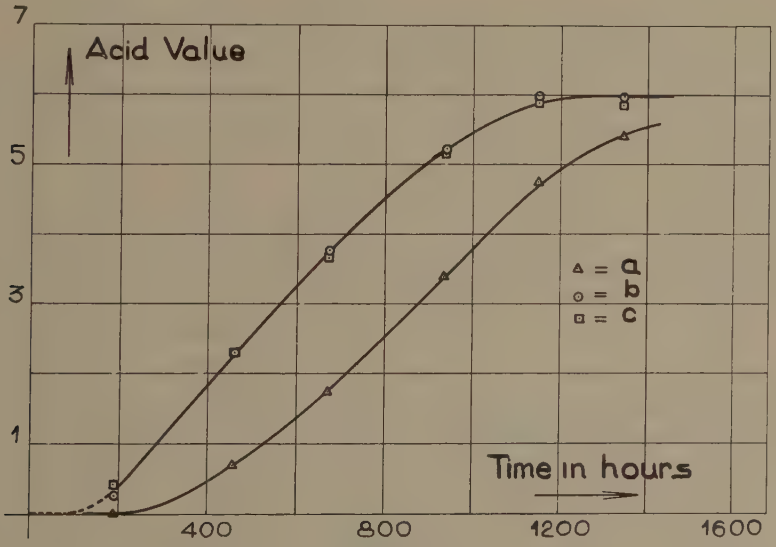

Fig. 2.

The curves *b* and *c* in fig. 2 are the same, so in our case it must be a homogeneous catalysis. The reason that the curve a lies lower than *b* and *c*, must be that after 30 hours there is not enough copper dissolved to

reach that range, in which the catalytic action is independent of the quantity of catalysing metal.

In the corrosion investigation (see publ. II) the authors have found subsequently that after about 100 hours copper is no more attacked due to the formation of a protecting film. By this fact it is not excluded that under certain circumstances there can be a heterogeneous catalysis also, viz. if the protecting film is not yet built up or is disturbed by external causes. This will be a subject of further investigation.

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Mathematics. — *Zur Konformgeometrie.* III. *Anwendung auf die Kurventheorie.* Von V. HLAVATÝ. (Communicated by Prof. J. A. SCHOUTEN).

(Communicated at the meeting of September 28, 1935).

In dieser Arbeit werden wir die Konforminvarianten einer Kurve $C(t)$ untersuchen. Dabei benützen wir die Ergebnisse der beiden vorangehenden Arbeiten[1]).

1. Es sei eine Kurve $C(t)$ durch ihre Gleichungen $x^\nu = x^\nu(t)$ in einer K_n gegeben[2]). Diese K_n kann zu einer $\overset{\circ}{W}_n$ gemacht werden, in der die Tensordichte $\mathfrak{g}_{\lambda\mu}$ kovariant konstant ist

$$\nabla_\omega \mathfrak{g}_{\lambda\mu} = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1,1)$$

(Vergl. K I). Ausgehend von dem Tangentialvektor dx^ν kann man längs C die eichinvariante Einheitsvektordichte (vom Gewicht $1/n$)

$$\underset{1}{\mathfrak{i}}^{\nu} = \mathfrak{i}^{\nu} = \frac{dx^\nu}{\sqrt{|\mathfrak{g}_{\lambda\mu}\, dx^\lambda\, dx^\mu|}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1,2)$$

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[1]) V. HLAVATÝ, „Zur Konformgeometrie" I (Proc. Vol. 38, p. 281), weitert zitiert als K I und V. HLAVATÝ, „Zur Konformgeometrie" II (Proc. Vol. 38, p. 738) weiter zitiert als K II.

[2]) Nach K I sind die aus $\mathfrak{g}_{\lambda\mu}$ entspringenden quadratischen Formen definit.

konstruieren. Dank der Gleichung (1,1) kann man mit den Begriffen $\mathfrak{g}_{\lambda\mu}$, $\mathfrak{i}^\nu$, $\mathfrak{i}^\mu \nabla_\mu$ genau so verfahren, wie mit den analogen Begriffen in dem metrischen Falle 3). Man bekommt dann die FRENETschen Formeln

$$\mathfrak{i}^\mu \nabla_\mu \underset{a}{\mathfrak{i}}^\nu = - \underset{a-1}{\mathfrak{k}}\, \underset{a-1}{\mathfrak{i}}^\nu + \underset{a}{\mathfrak{k}}\, \underset{a+1}{\mathfrak{i}}^\nu , \quad \ldots\ldots \quad (1,3)$$

$$(a = 1, \ldots, m \ , \ \underset{0}{\mathfrak{k}} = \underset{m}{\mathfrak{k}} = 0 \ , \ 1 \leqslant m \leqslant n).$$

Die eichinvarianten Einheitsvektordichten $\underset{2}{\mathfrak{i}}^\nu, \ldots, \underset{m}{\mathfrak{i}}^\nu$ bestimmen die Richtungen der ersten, ..., $(m-1)$-ten Normale der Kurve, während die eichinvarianten skalaren Dichten $\underset{1}{\mathfrak{k}}, \ldots, \underset{m-1}{\mathfrak{k}}$ als Krümmungen der Kurve betrachtet werden können. Von den eichinvarianten Einheitsvektordichten $\underset{a}{\mathfrak{i}}^\nu$, $(a = 1, \ldots, m)$ kann man zu den Einheitsvektoren

$$\underset{a}{i}^\nu = \underset{a}{\mathfrak{i}}^\nu \, \mathfrak{g}^{-\frac{1}{2n}} \quad \ldots\ldots \quad (1,4)$$

übergehen, die sämtlich derselben Klasse $-\frac{1}{2}$ sind ($\mathfrak{g}$ ist dabei der absolute Wert der Determinante von $g_{\lambda\mu}$).

2. Man kann auch die Methode mit dem Operatorkern $\triangle_\mu$ benützen, da auch

$$\triangle_\mu \, g_{\lambda\nu} = 0 \quad \ldots\ldots \quad (2,1)$$

ist. (Vergl. K I). Dazu ist nötig von dem Einheitsvektor der Klasse $-\frac{1}{2}$ auszugehen

$$\underset{1}{i}^\nu = i^\nu = \frac{dx^\nu}{\sqrt{|g_{\lambda\mu}\, dx^\lambda\, dx^\mu|}} .$$

Die Anwendung des Operators $\frac{dx^\mu}{dt} \triangle_\mu$ auf $\underset{1}{i}^\nu$ und auf die Vektoren, die daraus entspringen, ergibt uns

$$\frac{dx^\mu}{dt} \triangle_\mu \underset{a}{i}^\nu = - \underset{a-1}{k}\, \underset{a-1}{i}^\nu + \underset{a}{k}\, \underset{a+1}{i}^\nu \quad \ldots\ldots \quad (2,2)$$

$$(a = 1, \ldots, m \ , \ \underset{0}{k} = \underset{m}{k} = 0 \ , \ 1 \leqslant m \leqslant n).$$

Die eichinvarianten Skalare k sind mit den früher betrachteten Dichten $\mathfrak{k}$ eng verbunden, während die Vektoren $\underset{a}{i}^\nu$ der Gleichung (1,4) genügen.

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3) Vergl. z.B. D. J. STRUIK, „Grundzüge der mehrdimensionalen Differentialgeometrie ..“ (Springer, Berlin, 1922, S. 76).

Um dies einzusehen, gehen wir von der offenbar gültigen Gleichung

$$\underset{1}{\mathfrak{i}}^{\nu} = \underset{1}{i}^{\nu}\, \mathfrak{g}^{\frac{1}{2n}}$$

aus und berechnen das Resultat der Anwendung von $\mathfrak{i}^{\mu} \nabla_{\mu}$ auf $\underset{1}{\mathfrak{i}}^{\nu}$. Es zeigt sich dass

$$\mathfrak{i}^{\mu} \nabla_{\mu} \underset{1}{\mathfrak{i}}^{\nu} = \mathfrak{g}^{1/n} \left(i^{\mu} \nabla_{\mu} \underset{1}{i}^{\nu} - \tfrac{1}{2} Q_{\mu}\, i^{\mu} \underset{1}{i}^{\nu}\right) \quad . \; . \; . \; . \; . \; . \quad (2{,}3)$$

ist. Anderseits ist

$$i^{\mu} \triangle_{\mu} \underset{1}{i}^{\nu} = i^{\mu} \nabla_{\mu} \underset{1}{i}^{\nu} - \tfrac{1}{2} Q_{\mu}\, i^{\mu} \underset{1}{i}^{\nu}, \quad . \; . \; . \; . \; . \; . \quad (2{,}4)$$

weil der Einheitsvektor $\underset{1}{i}^{\nu}$ von der Klasse $-{}^{1}/_{2}$ ist. Der Vergleich von (2,3) und (2,4) lehrt

$$i^{\mu} \triangle_{\mu} \underset{1}{i}^{\nu} = \mathfrak{g}^{-1/n} \left(\mathfrak{i}^{\mu} \nabla_{\mu} \underset{1}{\mathfrak{i}}^{\nu}\right). \quad . \; . \; . \; . \; . \; . \; . \quad (2{,}5)$$

Geht man in diese Formel mit dem Wert

$$i^{\nu} = \frac{v^{\nu}}{v} \quad , \quad v = \sqrt{|\, g_{\lambda\mu}\, v^{\lambda}\, v^{\mu}\, |}$$

ein (wo der Kürze halber $v^{\nu} = \dfrac{dx^{\nu}}{dt}$ gesetzt wurde), so gibt uns der Vergleich von (1,3) und (2,2) erstens

$$\underset{2}{\mathfrak{i}}^{\nu} = \underset{2}{i}^{\nu}\, \mathfrak{g}^{\frac{1}{2n}}$$

und zweitens

$$\underset{1}{k} = v\, \underset{1}{\mathfrak{k}}\, \mathfrak{g}^{-\frac{1}{2n}}.$$

Ganz analog beweist man die Gültigkeit der Formel (1,4) für alle in (2,2) auftretenden Vektoren und ausserdem

$$\underset{b}{k} = v\, \underset{b}{\mathfrak{k}}\, \mathfrak{g}^{-\frac{1}{2n}} \qquad (b = 1, \ldots, m-1) \qquad (2{,}6)$$

3. Geht man nun von einem anderen Parameter ${}^{\backprime}t$ aus, so gibt uns das oben angeführte Verfahren (jetzt aber mit dem Operator $\dfrac{dx^{\mu}}{d\,{}^{\backprime}t} \triangle_{\mu}$) die zu (2,2) analogen Formeln mit den akzentuierten Grössen. Eine leichte Überlegung zeigt, dass für die Bestimmungszahlen der Vektoren $i^{\nu}, {}^{\backprime}i^{\nu}$ und für die Skalare $k, {}^{\backprime}k$ folgende Gleichung gilt:

$$\left|\, \underset{a}{{}^{\backprime}i}^{\nu} \right| = \left|\, \underset{a}{i}^{\nu} \right|, \; \left|\, \underset{b}{{}^{\backprime}k}\, d\,{}^{\backprime}t \right| = \left|\, \underset{b}{k}\, dt \right|, \; (a = 1, \ldots, m, \;\; b = 1, \ldots, m-1).$$

Zusammenfassend können wir also sagen:

Zu jeder Kurve in K_n kann man immer $m-1$ eichinvariante Normalrichtungen[4]), sowie auch $m-1$ eichinvariante Skalare

$$\left|\int \underset{b}{k}\, dt\right| \qquad (b=1,\ldots,m-1)$$

angeben ($1 \leqslant m \leqslant n$). Beide Begriffe sind auch gegenüber beliebiger Parametertransformation invariant.

Offenbar sind diese Begriffe von derselben Ordnung in bezug auf die Ableitungen von x nach t, wie im metrischen Falle.

4. Bis jetzt haben wir den Begriff des „Bogens" im Sinne eines ausgezeichneten Parameters überhaupt nicht verwendet. Es lässt sich aber zeigen, dass auch in diesem Falle unter allen zulässigen Parametern mindestens einer sich konforminvariant auszeichnen lässt. Zu diesem Zwecke schicken wir folgendes voraus: Der aus den Vektoren

$$i^\nu\,,\ \left(\frac{dx^\mu}{dt}\triangle_\mu\right)^b i^\nu \qquad (b=1,\ldots,m-1)$$

konstruierte einfache m-Vektor, der von der Klasse $-m/2$ ist, bestimmt eindeutig (bis auf das Vorzeichen) einen einfachen kontravarianten $(n-m)$-Vektor, der zu dem ursprünglichen orthogonal ist und die Klasse $-(n-m)/2$ besitzt. Beide Multivektoren bestimmen (bis auf das Vorzeichen) einen n-Vektor, der die Klasse $-n/2$ hat. Die dazugehörige Dichte vom Gewicht -1 bezeichnen wir mit $\mathfrak{w}$. Geht man nun von einem anderen Parameter ${}^{\backprime}t$ aus, so gibt uns dasselbe Verfahren die entsprechende Dichte ${}^{\backprime}\mathfrak{w}$. Eine leichte Rechnung zeigt, dass beide Dichten mittels

$$\mathfrak{w}=\varepsilon\left(\frac{d\,{}^{\backprime}t}{dt}\right)^{\frac{m(m-1)}{2}}{}^{\backprime}\mathfrak{w}\quad\ldots\ldots\ldots\quad(4{,}1)$$

gebunden sind. ε ist dabei $+1$, oder -1, je nachdem, ob man in beiden Konstruktionen die selben oder entgegengesetzte Vorzeichen des $(n-m)$-Vektors nimmt. — Die Formel (4,1) gestattet uns den eichinvarianten „Bogen" ${}^{\backprime}t$ zu definieren. Für diesen verlangen wir nämlich

$${}^{\backprime}\mathfrak{w}^2=\frac{1}{\mathfrak{g}},\quad\ldots\ldots\ldots\quad(4,2)$$

was eine invariante und zugleich eichinvariante Forderung darstellt. Nach (4,1) und (4,2) ist dieser Bogen mittels

$${}^{\backprime}t=\int_{t_1}^{t_2}(\mathfrak{w}^2\,\mathfrak{g})^{\frac{1}{m(m-1)}}\,dt\quad\ldots\ldots\ldots\quad(4{,}3)$$

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[4]) Auf die eventuelle Umorientierung dieser Richtungen gehen wir nicht näher ein.

gegeben. Dieser Bogen ist nicht nur von der Wahl des früher erwähnten $(n-m)$-Vektors unabhängig, sondern ist auch eichinvariant. Gegenüber dem metrischen Bogen ist er aber von einer zu hohen Ordnung in bezug auf die Ableitungen von x nach t, nämlich von der Ordnung m. Im Weiteren machen wir von diesem Bogen keinen Gebrauch mehr.

5. Zum Schluss wollen wir zeigen, wie die übliche geometrische Interpretation der Krümmungen einer Kurve in R_n auch hier ein Analogon hat. Zu diesem Zwecke betrachten wir längs der Kurve C ein Einheitsvektorfeld, das von der Lösung des Systems

$$\frac{dx^\mu}{dt} \triangle_\mu j^\nu = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5,1)$$

mit den Anfangsbedingungen $(j^\nu)_{t=0} = (\underset{a}{i}^\nu)_{t=0}$ gebildet wird.[5] Dann führen wir den Winkel $\underset{a}{\alpha}$ mittels der Gleichung

$$\cos \underset{a}{\alpha} = g_{\lambda\mu}\, j^\lambda\, \underset{a}{i}^\mu$$

ein. Weil diese Gleichung eine skalare Gleichung ist, deren jedes Glied die Klasse 0 hat, so ist nach (5,1)

$$\frac{d^p \cos \underset{a}{\alpha}}{dt^p} = g_{\lambda\mu}\, j^\lambda \left(\frac{dx^\rho}{dt} \triangle_\rho \right)^p \underset{a}{i}^\mu \quad , \quad (p=1, 2, \ldots) \quad . \quad . \quad . \quad (5,2)$$

Für die Entwickelung von $\cos \alpha$ in der Nähe von $t=0$ bekommen wir also nach (2,2) und (5,2)

$$\cos \underset{p}{\alpha} = 1 - \frac{t^2}{2!} (\underset{a-1}{k}^2 + \underset{a}{k}^2)_{t=0} + \ldots . \quad . \quad . \quad . \quad . \quad (5,3)$$

Hier sind die ausgelassenen Glieder mindestens dritter Grössenordnung in bezug auf t. Aus dieser Gleichung folgt

$$\lim_{t \to 0} \frac{\underset{p}{\alpha}^2}{t^2} = (\underset{a-1}{k}^2 + \underset{a}{k}^2)_{t=0} , \quad . \quad . \quad . \quad . \quad . \quad . \quad (5,4)$$

also eine Formel, die ganz analog der entsprechenden Formel in R_n ist, und neuerdings auch für V_n vom H. LEVY berechnet wurde.[6]

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[5] Wenn v^ν, von der Klasse 0, eine Lösung von

$$\frac{dx^\mu}{dt} \nabla_\mu v^\nu = \lambda\, v^\nu$$

darstellt, so zeigt eine leichte Rechnung, dass $j^\nu = \dfrac{v^\nu}{\sqrt{|g_{\lambda\mu}\, v^\lambda\, v^\mu|}}$ der Gleichung (5,1) genügt.

[6] H. LEVY, „Curvatures in RIEMANNian space". Bull. Amer. Math. Soc. **40**, S. 75—78, (1934). Wir haben oben eine andere, allgemein verwendbare Methode benützt.

6. Die hier auseinandergesetzte eichinvariante Behandlung der Kurven hat nur dann einen Sinn, wenn diese Kurven sich in einer, mit konform veränderlichen Metrik ausgestatteten, V_n befinden, welche zu einer $\overset{\circ}{W}_n$ gemacht werden kann. (Vergl. K I.) Diese $\overset{\circ}{W}_n$ unterscheidet sich von einer W_n (d.i. von einer n-dimensionalen Mannigfaltigkeit, die eine WEYL'sche Konnexion trägt) nur dadurch, dass der Vektor Q_α in $\overset{\circ}{W}_n$ ein Gradientvektor ist, während dies in einer W_n nicht der Fall ist. Wir haben aber nirgends diese Eigenschaft der $\overset{\circ}{W}_n$ benützt, so dass unsere Betrachtungen Wort für Wort auf die Kurventheorie in einer W_n übertragbar sind, und zwar diesmal ohne jede Einschränkung, bezüglich der Struktur der Konnexion:

Die hier angegebene Behandlung gilt wörtlich auch für Kurven in einer beliebigen W_n.

Prag, Oktober, 1934.

Chemistry. — *On the Crystal-Structure of Cerium tungstate.* By J. BEINTEMA. (Communicated by Prof. F. M. JAEGER).

(Communicated at the meeting of October 26, 1935).

§ 1. ZAMBONINI [1]) in a series of investigations first drew attention to the fact that the alcaline earth-metals as well as lead can isomorphously be substituted in their compounds by the rare earth-metals. From his results he concluded that *three* atoms of the metals *Ca*, *Sr*, *Ba* or *Pb* in their compounds can be substituted by *two* atoms of the rare earth-metals. The consequence of this is that in the crystalline structure a number of unoccupied positions must occur. If a relatively small percentage of the rare earth-metal is present in the mixed crystals, it may be assumed that the stability of the grating remains sufficiently great, so as to preserve the original crystal-structure, notwithstanding the perturbations which necessarily must be the consequence of the fact mentioned. But in some cases of this kind the existence of an uninterrupted mixing-series from 0—100 % was actually proved by the experiments. Such a case occurs, for instance, in the binary system: $PbWO_4$—$Ce_2(WO_4)_3$: the most probable supposition to be made in this case would be to assume for pure *cero-tungstate* a crystalline structure completely isomorphous with that of *scheelite*. If this were true, only two thirds of the positions occupied by the cations would be substituted, while the remaining places would be void of substitutes. In the case of these greater concentrations these inoccupied places — for which, therefore, PAULING's electrostatic valence principle ¹) does not hold — would become rather numerous and it seemed very desirable to check the supposed crystalline structure of the *cerium* salt by means of *X*-ray-analysis. Already ZAMBONINI and LEVI ²) prepared some powder-spectrograms of rare-earth-molybdates and of the corresponding salts of the alkaline earth-metals, by which an analogous structure of these different compounds appeared highly probable; but, as ZAMBONINI assumed a too small elementary cell, his interpretation of the spectrograms obtained was erroneous and only the fact that either the fainter diffraction lines did not occur in his spectrograms or were not taken into account, must be the cause of it having been possible at all to check the images in the usual way.

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[1]) J. F. ZAMBONINI, Bull. soc. franç. min. **38**, 206 (1915).

§ 2. In this paper, therefore, a renewed and more complete investigation of the crystalline structure of *cerium tungstate* is published; this salt was chosen in connection with its true miscibility with $PbWO_4$, this having been demonstrated by ZAMBONINI ³) as early as 1913. The crystals desired were, according to the prescription of this author, obtained by melting of the salt with sodium chloride as a flux: they had the shape of tetragonal bipyramids, the larger of which were mostly badly developed and showed oscillating angular values; but finally some smaller crystals proved to be better built and sufficiently adapted for the purpose. A series of rotation-spectrograms made with the crystals really manifested the typical character of a *scheelite*-like built structure: thus for instance, reflections (hkl) with $(h+k+l)=$ *odd*, do not occur. Those with $(h+\frac{1}{2}l)=$ *even* have a great intensity; those with $(h+\frac{1}{2}l)=$ *odd*, on the contrary, either do not occur or are only extremely faint, while those for which l is *odd*, in general show a mediocre intensity. The crystals at our disposal were too small for the purpose of studying their LAUE-images; but from the rotation-spectrograms it readily could be concluded that the deviations from ditetragonal symmetry, — if present at all, — only could be unappreciable, as beforehand might be expected for a *scheelite*-like structure. The elementary cell contains a mass: $Ce^{8/3}(WO_4)_4$; the unoccupied places in the grating must statistically be distributed over the available positions, because a regular distribution necessarily would extend itself over a greater number of cells and this would practically lead to the presence of a greater fundamental cell. However, the latter would involve the manifestation of a series of interjacent accessory spectra in the oscillation-spectrograms, between those actually observed, — of which no indication was found. A powder-

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¹) L. PAULING, J. Am. Chem. Soc. **51**, 1010 (1929).

²) J. F. ZAMBONINI and R. G. LEVI, Rend. d. R. Accad. dei Lincei **2**, 149, 225, 303, 377, 462 (1925).

³) J. F. ZAMBONINI, Rend. d. R. Accad. dei Lincei **12** (5*a*), 519 (1913).

Powder-spectrogram of $Ce_2\,(WO_4)_3$ + Silver.

No. of line	Distance $2l$ in cm	Intensity (visual)	Angle θ	$\sin^2\theta$ observed	$\sin^2\theta$ of silver	$\sin^2\theta$ corrected	$\sin^2\theta$ calculated	Indices (hkl)	Wave-length λ
1	3.637	4	9° 4′	0.0248		0.0250	0.0251	(101)	α
2	5.046	2	12°35′	0.0475		0.0478	0.0481	(112)	β
3	5.614	10	14° 0′	0.0586		0.0591	0.0591	(112)	α
4	6.124	3	15°17′	0.0695		0.0700	0.0701	(004)	α
5	6.682	5	16°40′	0.0823		0.0829	0.0831	(200)	α
6	6.833	2	17° 3′	0.0860	0.0870				
7	7.613	10	19° 0′	0.1060	0.1067				
8	8.851	8	22° 5′	0.1413	0.1423				
9	9.196	7	22°57′	0.1520		0.1530	0.1532	(204)	α
10	9.505	2	23°43′	0.1618		0.1629	0.1622	(116)	β
11	9.608	4	23°58′	0.1650		0.1661	0.1662	(220)	α
12	10.147	1	25°19′	0.1829		0.1841	0.1832	(312)	β
13	10.397	1	25°56′	0.1913		0.1925	0.1913	(301)	α
14	10.591	5	26°25′	0.1981		0.1993	0.1992	(116)	α
15	10.990	2	27°25′	0.2120		0.2133	0.2133	(215)	α
16	11.318	6	28°14′	0.2238		0.2252	0.2252	(312)	α
17	11.624	4	29° 0′	0.2350		0.2364	0.2362	(224)	α
18	12.641	1	31°32′	0.2736		0.2751	0.2744	(321)	α
19	12.786	1	31°54′	0.2792		0.2808	0.2803	(008)	α
20	12.882	6	32° 8′	0.2830	0.2846				
21	13.198	2	32°56′	0.2956		0.2972	0.2964	(305)	α
22	13.505	3	33°42′	0.3078		0.3094	0.3094	(323)	α
23	13.755	3	34°19′	0.3178	0.3190				
24	14.063	3	35° 5′	0.3304		0.3321	0.3324	(400)	α
25	14.849	6	37° 3′	0.3630		0.3648	0.3634 0.3653	(208) (316)	α α
26	15.477	7	38°37′	0.3895	0.3913				
27	15.735	5	39°16′	0.4005		0.4024	0.4024	(404)	α
28	16.048	4	40° 2′	0.4138		0.4157	0.4155	(420)	α
29	16.303	4	40°41′	0.4248	0.4258				
30	16.765	3	41°50′	0.4448		0.4467	0.4465	(228)	α
31	17.517	4	43°42′	0.4774		0.4793	0.4795	(1.1.10)	α
32	17.664	4	44° 4′	0.4838		0.4857	0.4855	(424)	α
33	18.510	1	46°11′	0.5206		0.5225	0 5237	(501) (431)	α
34	18.737	2	46°45′	0.5305		0.5324	0.5316	(336)	α
35	19.325	3	48°13′	0.5560		0.5579	0.5576	(512)	α
36	19.575	3	48°50′	0.5668	0.5691				

Powder-spectrogram of $Ce_2\,(WO_4)_3$ + Silver (continued).

No. of line	Distance $2l$ in cm	Intensity (visual)	Angle θ	$\sin^2\theta$ observed	$\sin^2\theta$ of silver	$\sin^2\theta$ corrected	$\sin^2\theta$ calculated	Indices (hkl)	Wave-length λ
37	20.601	2	51°24′	0.6108		0.6126	0.6122	(408)	α_1
38	20.652	1	51°32′	0.6129		0.6147	0.6152	(408)	α_2
39	21.386	3	53°21′	0.6438		0.6455	0.6451	(3.1.10)	α_1
40	21.440	2	53°30′	0.6461		0.6478	0.6483	(3.1.10)	α_2
41	22.109	5	55°10′	0.6737	0.6752				
42	22.168	4	55°17′	0.6756	0.6786				
43	22.612	4	56°25′	0.6940		0.6955	0.6951	(428)	α_1
44	22.693	3	56°37′	0.6972		0.6987	0.6986	(428)	α_2
45	23.000	5	57°23′	0.7095	0.7107				
46	23.076	4	57°34′	0.7125	0.7143				
47	23.308	4	58° 9′	0.7216		0.7230	0.7232	(532)	α_1
48	23.381	3	58°20′	0.7244		0.7258	0.7268	(532)	α_2
49	23.607	4	58°54′	0.7332		0.7346	0.7342	(444)	α_1
50	23.712	3	59°10′	0.7372		0.7386	0.7379	(444)	α_2
51	25.292	2	63° 6′	0.7953		0.7963	0.7961	(2.2.12)	α_1
52	25.398	1	63°22′	0.7990		0.8000	0.8001	(2.2.12)	α_2
53	25.723	2	64°11′	0.8103		0.8113	0.8111	(3.3.10)	α_1
54	25.796	2	64°25′	0.8136		0.8146	0.8152	(3.3 10)	α_2
55	26.298	2	65°37′	0.8296		0.8305	0.8302	(620)	α_1
56	26.441	1	65°58′	0.8341		0.8350	0.8344	(620)	α_2
57	27.011	5	67°24′	0.8522	0.8528				
58	27.138	4	67°43′	0.8561	0.8571				
59	27.361	4	68°16′	0.8629		0.8636	0.8632	(536)	α_1
60	27 495	3	68°36′	0.8669		0.8676	0.8675	(536)	α_2
61	28.675	4	71°33′	0.8998		0.9003	0.9002	(624)	α_1
62	28.841	3	71°57′	0.9041		0.9046	0.9048	(624)	α_2
63	31.400	6	78°21′	0.9592	0.9594				
64	31.716	5	79° 8′	0.9645	0.9643				

Effective Radius of Camera: $R = 5.742$ cm.

Wave-length (Cu_K):

$\lambda(\alpha) = 1.538\,\text{Å}$; $\lambda(\alpha_1) = 1.5374\,\text{Å}$; $\lambda(\alpha_2) = 1.5412\,\text{Å}$; $\lambda(\beta) = 1.389\,\text{Å}$.

Quadratic Equation:

$$\sin^2\theta = 0.02077_3\,(h^2 + k^2) + 0.004379_3\,.\,l^2. \qquad (\alpha)$$

spectrogram, — *silver* being used as a standard of comparison, — yielded: $a_0 = 5.33_6$ Å, $c_0 = 11.62_0$ Å, the axial ratio $a:c$ being $1:2.178$. The calculated value of the specific weight is: 6.81_3. According to ZAMBONINI the specific weight is *6.78*, so that the assumption concerning the mass present within the elementary cell proves to be right.

REVIEW.

In this paper the crystalline structure of *Cerium tungstate* was studied by means of *X*-ray-analysis. The substance is tetragonal-bipyramidal and possesses a *scheelite*-like structure, with $a_0 = 5.33_6$ Å, and $c_0 = 11.62_0$ Å, $(a:c = 1:2.178)$ and a mass: $Ce^{8/3}\,(WO_4)_4$ within its elementary cell. Only $^2/_3$ of the positions of the *lead*-atoms in $PbWO_4$, which forms an uninterrupted mixing-series with it, are occupied by *cerium*-atoms in $Ce_2(WO_4)_3$, the remaining places being void of atoms. Notwithstanding these empty places, the crystal-structure of the mixed crystals of both salts and of the crystals of *cerium tungstate* itself proves to remain sufficiently stable.

This investigation was carried out with the experimental resources and the means of the Laboratory for Inorganic Chemistry of the University.

Groningen, Laboratory for Inorganic and
Physical Chemistry of the University.

Chemistry. — *On the Crystal-structure and the Composition of Sodium-dihydro-pyrostibiate.* By J. BEINTEMA. (Communicated by Prof. F. M. JAEGER).

(Communicated at the meeting of October 26, 1935).

§ 1. In connection with the values of the ionic radii calculated by L. PAULING [1]), this author drew the conclusion that pentavalent *antimony* in its compounds would have the co-ordination number *six*. By an investigation of O. ZEDLITZ [2]) concerning the crystal-structure of the minerals *romeite* and *schneebergite* it was, indeed, demonstrated by the author that every *Sb*-ion in its crystalline architecture is surrounded by *six* atoms of *oxygen* situated in the corners of an octahedron, compressed in the direction of one of the trigonal axes. In accordance with this, PAULING suggested that the salt commonly discerned as *sodiumdihydro-pyrostibiate*,

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[1]) L. PAULING, J. Am. Chem. Soc. **55**, 1895 (1933).

[2]) O. ZEDLITZ, Z. Krist. **81**, 253 (1932).

$Na_2H_2Sb_2O_7 . 5\,H_2O$, really would be derived from the hypothetical acid: $HSb(OH)_6$, — its true formula, therefore, being: $NaSb(OH)_6$.

The number of water-molecules of this salt is variously indicated in the literature: from a boiling solution a precipitation is formed which, according to the analysis, has the composition: $Na_2H_2Sb_2O_7 . 5\,H_2O$, while at room-temperature a salt with $6\,H_2O$ would be formed. However, the water-content seems by no means to be constant, as often values between 5 and $6\,H_2O$ are observed.

From the powder-spectrograms the complete identity of the products obtained at lower or at higher temperatures can be deduced; the higher water-content, therefore, most probably seems to be caused by the inclusion of the mother-liquor. This is corroborated by comparison of the specific weight as deduced from spectroscopic measurements with that actually determined.

A tentative is made in this paper to deduce the right composition of this salt by means of *X*-ray-analysis of the crystalline substance.

§ 2. Crystals obtained by slow diffusion of solutions of *sodium chloride* and *potassiumdihydro-pyrostibiate* into each other proved sufficiently large as to allow a detailed investigation. They usually have the form of apparent octahedra with their corners and edges often truncated by other planes. The crystals are in reality *tetragonal* (pseudo-cubic) with the axial ratio: $a:c = 1:0{,}983$; they are limited by the forms: $o = \{111\}$ predominant; $c = \{001\}$, well developed; $m = \{110\}$ and $a = \{100\}$, — the latter often being absent. Only occasionally some crystals still showed a subordinate form $s = \{221\}$.

Angular Values:	*Observed*:	*Calculated*: (from the spectroscopical data)
$o:c = (111):(001) =$	54° 17′	54° 16′
$o:m = (111):(110) =$	35 43	35 44
$a:m = (100):(110) =$	45 5	45 0

The crystals were previously measured by HAUSHOFER [1]), who also stated their tetragonal symmetry, but erroneously found the axial ratio $a:c = 1:1{,}0079$; the crystallographical as well as the spectroscopical investigation proves that the *c*-axis is *shorter* than the *a*-axis.

The crystals are feebly birefringent with a negative character; the indices of refraction [2]) are: $\varepsilon_{577} = 1.605$; $\omega_{577} = 1.598$.

A crystal tabular to {001} in convergent light showed the axial image of a negative, uniaxial crystal without circular polarization.

A LAUE-pattern made perpendicularly at (001) proved the absence of vertical symmetry-planes. As no piezo-electrical properties could be found, the most probable symmetry of the crystals, — also in connection with their external development, — is the *tetragonal-bipyramidal* one.

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[1]) K. HAUSHOFER, Z. Krist. **4**, 52, (1880).

[2]) Determined by Dr. P. TERPSTRA.

The cell-dimensions were deduced by means of some oscillation-spectrograms round [001] and [110] and checked by means of powder-spectrograms, in which *silver* was used as a standard of comparison: $a_0 = 8{,}00_5$ Å; $c_0 = 7{,}86_8$ Å; $a : c$ thus being $1 : 0{,}983$. As the volume of this cell is: $504 \, . \, 10^{-24}$ cm³ and the specific weight determined was 3,20, the cell contains the mass: $(Na_2H_2Sb_2O_7 \, . \, 5\,H_2O)_2$; the calculated specific weight in this case is: 3,22.

As may be seen from the tables I and II, the reflections of great intensities are those for which either all indices are even, or all are odd. Of the reflections with mixed indices only a few, like (301), (231), (103), and (213), show rather good intensities.

Evidently the atoms with the highest diffracting power: the *Sb*-ions, are arranged in a grating, which is centred in all the lateral and basal faces.

§ 3. As to the space-group present, only those need to be taken into account, which correspond to a simple tetragonal grating. As the reflections $(hk0)$ are absent when $(h+k)$ is *odd* and those of the form $(00l)$ when l is *odd*, most probably the space-group C_{4h}^4 is the right one, although: C_{4h}^1, C_{4h}^2 *and* C_{4h}^3 are not excluded either with absolute certainty, because the most powerfully diffracting atoms do not occupy the most general positions. However, C_{4h}^4 seems to be the most probable one, as only in this group a fourfold position occurs in the form of a grating centred in all its cellular faces.

As in general the reflections with odd indices prove to be feebler than those with even indices, it is feasible to suppose that the four *Na*-ions occupy the fourfold position $4(d)$ in WYCKOFF's Table [1]), when the *Sb*-ions are placed in the position $4(c)$. Thus they form together a *sodium-chloride*-like arrangement, slightly compressed in the direction of the tetragonal *c*-axis. In this way it becomes clear that *no* groups (Sb_2O_7) are present in the structure, but that the anions contain only a single *Sb*-atom. The pseudo-cubic structure as well as the low optical birefringency seem to indicate that these anions are rather highly symmetrical [2]), so that the 24 *O*-atoms must be distributed in space in such a way, that the complexes thus formed really possess a high symmetry. The only way in which this can be done is by making the supposition of each *Sb*-atom being surrounded by 6 octahedrically, or at least approximately octahedrically, arranged *O*-atoms, — exactly as was suggested by PAULING's views about the structure of this salt.

As the *O*-atoms can only occupy three different eightfold positions

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[1]) L. W. G, WYCKOFF, *The analytical Expression*, etc. p. 81.

[2]) W. A. WOOSTER, Z. Krist. **80**, 495, (1931).

TABEL I.

Powder-spectrogram of Sodiumdihydro-pyrostibiate + Silver.

No. of line	Distance $2l$ in cm	Intensity (visual)	Angle θ	$\sin^2\theta$ observed	$\sin^2\theta$ of silver	$\sin^2\theta$ corrected	$\sin^2\theta$ calculated	Indices $(h\,k\,l)$
1	3.865	8	9°38′	0.0280		0.0280	0.0280	(111)
2	4.445	6	11° 4′	0.0369		0.0369	0.0369	(200)
3	4.516	5	11°15′	0.0381		0.0381	0.0382	(002)
4	6.354	5	15°50′	0.0744		0.0743	0.0738	(220)
5	6.394	5	15°56′	0 0754		0.0753	0.0751	(202)
6	6.892	3	17°10′	0.0872	0.0870			
7	7.478	5	18°38′	0.1021		0.1018	0.1018	(311)
8	7.663	10	19° 5′	0.1070	0.1067			
9	7.854	5	19°34′	0.1122		0.1119	0.1121	(222)
10	8.908	6	22°12′	0.1428	0.1423			
11	9.079	3	22°37′	0.1479		0.1474	0.1476	(400)
12	9.216	2	22°58′	0.1524		0 1519	0.1528	(004)
13	10.043	4	25° 1′	0.1789		0.1783	0.1783	(313)
14	10.246	7	25°32′	0.1858		0.1852	{0.1846 {0.1859	(420) (402)
15	10.375	5	25°51′	0.1901		0.1895	0.1898	(204)
16	11.325	6	28°13′	0.2235		0.2228	0.2228	(422)
17	11.427	5	28°28′	0.2273		0.2267	0.2267	(224)
18	12.068	4	30° 4′	0.2510		0.2503	{0.2495 {0.2521	(511) (333)
19	12.245	3	30°31′	0.2577		0.2570	0.2573	(115)
20	12.958	5	32°17′	0.2853	0.2846			
21	13.360	3	33°17′	0.3013		0.3005	0.3005	(404)
22	13.975	3	34°49′	0.3260		0.3252	0.3233 0.3259	(531) (513)
23	14.130	3	35°12′	0.3324		0.3316	{0.3311 {0.3322 {0.3335	(531) (600) (442)
24	14.268	3	35°33′	0.3380		0.3372	0.3374	(424)
25	15.060	4	37°31′	0.3710		0.3702	0.3705	(602)
26	15.306	3	38° 8′	0.3814		0.3806	0.3809	(206)
27	15.563	5	38°47′	0.3923	0.3913			
28	15.937	4	39°43′	0.4082		0.4073	0.4074	(622)
29	16.396	3	40°51′	0.4278	0.4268			

Effective Radius of Camera: $R = 5.749$ cm.

Wave-length: $\lambda_{Cu-K_\alpha} = 1.538$ Å

Quadratic Equation:

$$\sin^2\theta = 0.00922_9 \, . \, (h^2 + k^2) + 0.00955_4 \, . \, l^2.$$

Parameters of the Lattice: $a_0 = 8.00_5$ Å; $c_0 = 7.86_8$ Å.

Reflections observed on oscillation-spectrograms round [001] with visually estimated intensities.

Principal Spectrum		1st Accessory Spectrum		2nd Accessory Spectrum		3rd Accessory Spectrum	
Indices (hkl)	Int.	Indices (hkl)	Int.	Indices (hkl)	Int.	Indices (hkl)	Int.
(200)	10	(301)	6	(202)	10	(103)	9+
(400)	10	(111)	9+	(302)	3+	(113)	10
(600)	5+	(311)	6	(402)	10	(213)	5
(220)	10	(511)	7	(602)	8+	(313)	8+
(420)	10	(711)	7	(112)	3	(513)	6+
(620)	9+	(131)	10	(312)	3	(503)	2
(330)	3+	(231)	6	(222)	10	(123)	3
(240)	10	(331)	9+	(422)	10	(133)	9
(440)	10	(531)	9	(622)	8+	(333)	9
(640)	9+	(731)	7	(232)	3+	(533)	7+
(260)	8+	(341)	2+	(432)	2	(153)	7
(460)	8+	(151)	9	(142)	3	(173)	7
		(351)	7+	(242)	10	(173)	7
		(551)	8	(342)	3	(373)	7
		(361)	3	(442)	9+		
		(171)	6	(642)	8+		
		(371)	7+	(262)	9		
				(462)	9+		

$(x_1y_1z_1)$, $(x_2y_2z_2)$ and $(x_3y_3z_3)$, nine parameters must be determined so as to fix their true positions. Certain approximations of these parameter-values can nevertheless be deduced by considering some particular intensities more in detail: for (311) and (600) are relatively less intensive, so that here the *O*- and *Sb*-atoms seem to be in opposite phases. Moreover, the reflections (301) and (103) are exclusively caused by the influence of the *O*-atoms. In this way the following approximate values were finally chosen:

x_1	y_1	z_1	,	x_2	y_2	z_2	,	x_3	y_3	z_3 .
0,35	0,15	0,20		0,35	0,45	0,05		0,05	0,30	0,15

Thus the 4 *Sb*-ions in the position 4(c) are all surrounded by 6 *O*-atoms arranged in the corners of a more or less deformed octahedron.

The structure-factor:

$$| S_{(hkl)} |^2 = | \sum_j \psi_{j'} \, e^{2\pi i (hx_j + ky_j + lz_j)} |^2$$

of some reflexions calculated from these parameters is:

$$|S_{(600)}|^2 = 1{,}66 \,.\, 10^4 ; \; |S_{(620)}|^2 = 9{,}80 \,.\, 10^4 ;$$
$$|S_{(311)}|^2 = 6{,}76 \,.\, 10^2 ; \; |S_{(131)}|^2 = 2{,}56 \,.\, 10^4 ; \; |S_{(301)}|^2 = 6{,}22 \,.\, 10^3 .$$

From these data the relatively low intensity of (600) in comparison with that of (620), as well as the difference in intensity of (311) and (131), and the rather great intensity of (301), can readily be deduced, although the values prove to be somewhat deviating from those to be expected, as stated by the rather rough visual estimations.

In broad lines, however, the structure established appears to give a satisfactory explanation of the properties observed with this compound.

REVIEW.

In this paper the crystal-structure of *sodiumdihydro-pyrostibiate* was investigated. The salt crystallizes in the *tetragonal-bipyramidal* class. The dimensions of the elementary cell are:

$a_0 = 8.00_5$ Å; $c_0 = 7.86_8$ Å and contains a mass: $\{Na_2H_2Sb_2O_7 \,.\, 5H_2O\}_2$

The atomic positions are:

for $4\,Sb : 4\,(c)$: $\frac{1}{4}\;\frac{1}{4}\;0 ;\; \frac{3}{4}\;\frac{1}{4}\;\frac{1}{2} ;\; \frac{3}{4}\;\frac{3}{4}\;0 ;\; \frac{1}{4}\;\frac{3}{4}\;\frac{1}{2}$.
for $4\,Na : 4\,(d)$: $\frac{1}{4}\;\frac{1}{4}\;\frac{1}{2} ;\; \frac{3}{4}\;\frac{1}{4}\;0 ;\; \frac{3}{4}\;\frac{3}{4}\;\frac{1}{2} ;\; \frac{1}{4}\;\frac{3}{4}\;0$.
for $24\,O : 8\,(g)$: $x\,y\,z ;\; \bar{y}\,x\,z+\frac{1}{2} ;\; \bar{x}\,\bar{y}\,z ;\; y\,\bar{x}\,z+\frac{1}{2} ;$
$\frac{1}{2}-x\;\frac{1}{2}-y\;\bar{z} ;\; y+\frac{1}{2}\;\frac{1}{2}-x\;\frac{1}{2}-z ;\; x+\frac{1}{2}\;y+\frac{1}{2}\;\bar{z} ;\; \frac{1}{2}-y\;x+\frac{1}{2}\;\frac{1}{2}-z .$

with $x_1 = 0{,}35 \quad y_1 = 0{,}15 \quad z_1 = 0{,}20$
$x_2 = 0{,}35 \quad y_2 = 0{,}45 \quad z_2 = 0{,}05$
$x_3 = 0{,}05 \quad y_3 = 0{,}30 \quad z_3 = 0{,}15 .$

The cations and anions form a *sodiumchloride*-like grating; in each anion a *Sb*-atom is surrounded by 6 O-atoms in an almost octahedral configuration. The structure is in accordance with PAULING's view of the substance having the composition: $NaSb(OH)_6$.

These investigations were carried out with the means and resources of the Laboratory for Inorganic Chemistry of the University.

Groningen, Laboratory for Inorganic and
Physical Chemistry of the University.

Anthropology. — *The degree of the developmental changes in the length-breadth index of the head of Dutch Askenasim Jews.* By W. KLEIN, med. cand., Amsterdam (Communicated by Prof. Dr. C. U. ARIËNS KAPPERS.)

(Communicated at the meeting of October 26, 1935).

It more and more appears that the customary way of expressing the cephalic index, typical of a race or a group of people, by the average of all the indices, its standard deviation and spread, is less accurate than the use of frequency curves. No race whatever being pure, the latter method enables us to detect heterogeneous components.

Besides, this method may teach us a good deal about the natural division, the natural system of indices, i.e. which indices are the most frequent in man. —

Evidently the division of indices, hitherto used, into dolichocephalic (70—74,9), mesocephalic (75—79,9), brachycephalic (80—84,9), hyperbrachycephalic (85—89,9), and ultrabrachycephalic groups (90 and higher) is not based on the object itself, but on our decimal system. We should, however, not dictate nature its divisions, but nature has to dictate us its divisions, preferences, and standards, and evidently we can only understand its language in this matter by spelling its alphabet, i.e. by plotting all the data it gives us, without making averages of these data. —

Another advantage of this method for our purpose is that the changes in the indicial relations from childhood to the adult stage may be more precisely defined in various races and consequently better understood, — which again may cast some light on racial differentiations, as have occurred in the course of millennia, creating a large diversity from a probably less diverse original stock.

In order to contribute a little to the problem of indicial changes in the development of the head and its possible bearing on racial differentiation I examined those changes with the Askenasim population of Amsterdam.

From the researches of BONNIFAY 1) and RANKE 2) we know that with the children of brachycephalic races up to 2 or 3 years an increase of the index occurs, followed from the 2nd—3rd year onwards by a decrease.

The latter fact may be also concluded from BOAS' 3) measurements. BOAS has shown that this decrease may be favoured by special environmental circumstances of the parents (and consequently of the children).

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1) Thèse de Lyon. 1897.

2) Arch. f. Anthrop. Bnd. **31**. 1905.

3) Columbia University Contributions to Anthropology, Vol. **6**, 1928.

The influence of environment on the development of the head was confirmed by GUTHE ¹) and HIRSCH ²).

From the frequency curves of indices of Jews published by GUTHE, KAPPERS ³) concluded that certain indices have a predilection, and that these predilections correspond with predilections occurring with the main stocks of the Asiatic population north the Himalaya and in Europe north of the 40th parallel approximately: the so-called paleo-Asiatic (79—81) and Central-Asiatic 83—86 index types. He concluded from this that these two main Eurasian groups, as far as the index is concerned, may be related at their roots, and furthermore showed the wide spread of these indicial types in North and South America. —

The aim of my investigation was to examine in the same way the developmental changes of the cephalic index with the so-called German Jewish, better Askenasim population of Amsterdam, in order to know if the index types prevailing with the main Eurasian stocks mentioned above are found also during the development from childhood to the adult stage in this Jewish population of Amsterdam.

As the decrease of the index (vide supra) starts about the 2nd or 3rd year, I measured 1030 Amsterdam Askenasim, ranging from the age of 3½ years on; 673 males and 357 females.

The results of these measurements are striking and fully confirm the deduction that the Central-Asiatic index type occurs as a transitional type in the development of these people who in the adult stage have a prevailing paleo-Asiatic index curve. —

In order to give a visual representation of my results, I divided my male material into three groups, the boys below 10 years, those of 10—14 years, and adults. With the females — less in number — only two divisions were made, viz. girls below 10 years and adults, the number of girls from 10—14 years measured being too small (37) to give a reliable curve. In figs. 1—4 each point stands for two, in fig. 5 for one individual.

Studying the frequency curves of the males (figs. 1—3), we see that with the boys of 3½—10 years three outstanding peaks occur, the 79, 81 and 83 peak. In addition there is a distinct peak of 86 and a small ultrabrachycephalic elevation at 90 (for the mesocephalic 77 peak see below). The 83 and 86 peaks are typical of a so-called Central-Asiatic index curve, the 79 and 81 of a so-called paleo-Asiatic index curve.

With the boys of 10—14 years the ultrabrachycephalic peak (90) and the hyperbrachycephalic 86 peak have disappeared. Of the so-called Central-Asiatic peaks only the 83 peak remained, thus confirming KAPPERS' statement (l.c. supra) that of the Central-Asiatic peaks the 83 peak has a

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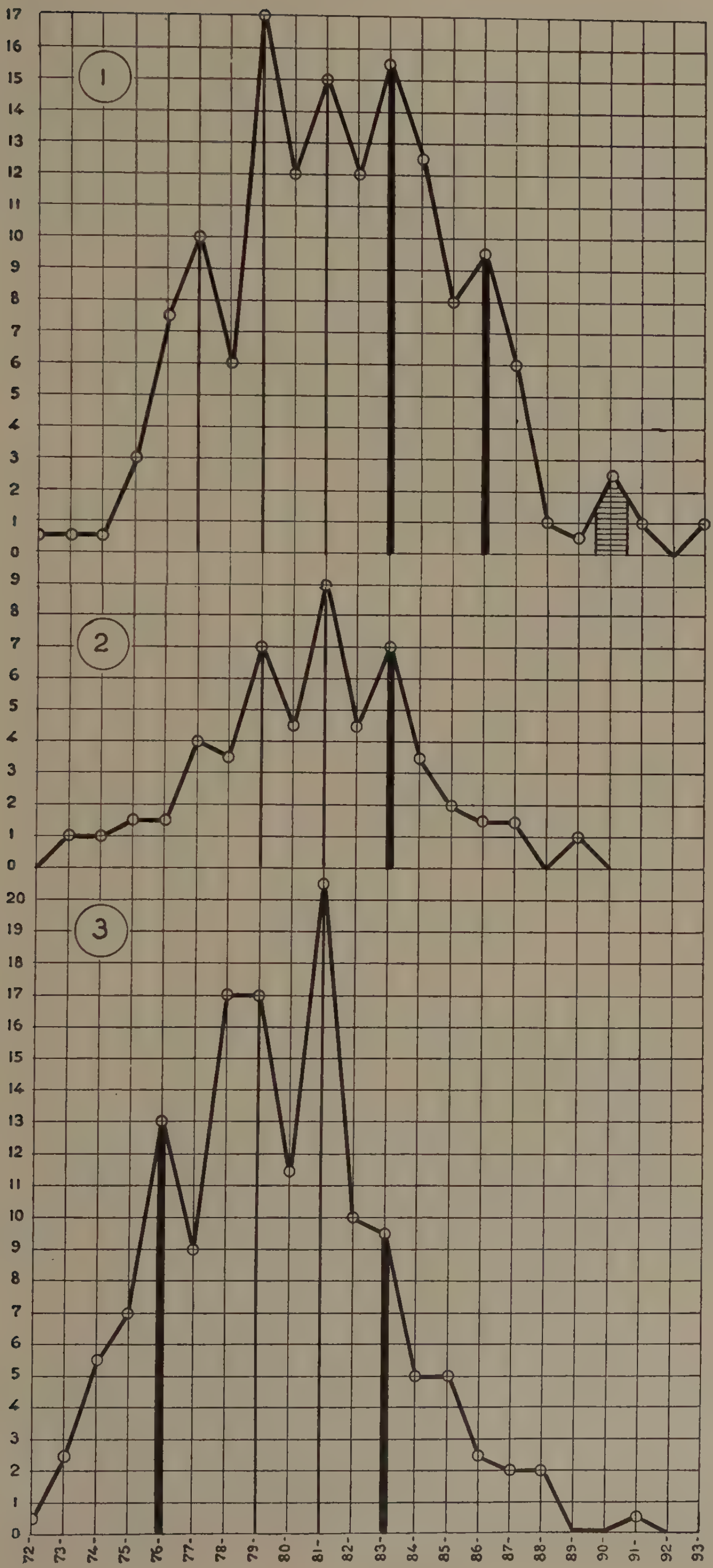
¹) American Journ. of physical Anthropology. Vol. I. 1918.

²) Ibidem. Vol. **10**. 1927.

³) These Proceedings. Vol. **38**. N⁰. 7. 1935, p. 686.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greater constancy than the 86 one and that the 90 peak is still more recessive.

The chief index with the 10—14 years boys is the paleo-Asiatic 81 peak, not the 79 peak, which is represented by a slightly smaller elevation.[1])

Turning to fig. 3, the adult males, we see that with them also the 83 index has greatly decreased, some prevalence of this index being indicated only by a steep rise from 84 to 83. As with the 10—14 years boys the 81 peak is the highest. In reality, however, the greatest increase occurs with the mesocephalic paleo-Asiatic index. The 78 index being nothing but a variation of the 79 index, the number of the paleo-Asiatic 78—79 indices exceeds the 81 peak in this group far more than in the 3½—10 years of fig. 1 (for the 76 peak see below).

Studying our female material (cf. fig. 5 and 6), we find that the developmental changes are not nearly so striking as they are with the boys, a fact confirming that the female sex is much more apt to cling to its infantile characteristics.

Yet, although there is a great similarity between the curves of figs 5 and 6, some differences may be observed: 1⁰. the 3½—10 years girls have a more pronounced 86 peak than the adult women and 2⁰. the ultrabrachycephalic index (90), though small in each, is somewhat more pronounced with the children (1½ %) than with the adults (¾ %). Similarly the 83 index, though not forming a peak in either of the female curves, is more numerous in the 3½—10 years group (10 %) than in the adult group (6.6 %). The greatest contrast, however, is exhibited by the relative frequency of both paleo-Asiatic indices, the 78—79 and 81 indices. In both curves the 81 peak is the highest, but the additional 78—79 peak of the 3½—10 years girls has increased to a much higher elevation in the adults.

I may add a few words about the 76 index, not outstanding in the children of either sex, but represented by a distinct peak in the adult males and by a steep elevation in the adult females.

As pointed out by KAPPERS[2]), this index has a pronounced Mediterranean character. Apart from the fact that it is a very regular occurrence with Hamitic and related African peoples, it also occurs with BOAS' Sicilian born Sicilians. With them, however, as well as with our material the 76 index becomes outstanding specially with the adults, and — as with BOAS' Sicilian women (see KAPPERS' paper in these Proceedings Table II fig. 16) — it is preceded by a higher index (77 usually). The same is seen in what may be a Mediterranean admixture to our Askenasim boys, where the 77 index of the male 3½—10 years and 10—14 years groups seems be replaced by a 76 index in the adults. Similarly with the female Askenasim the relation of the 76 to the 77 index shows an increase of the 76 index in the adults.

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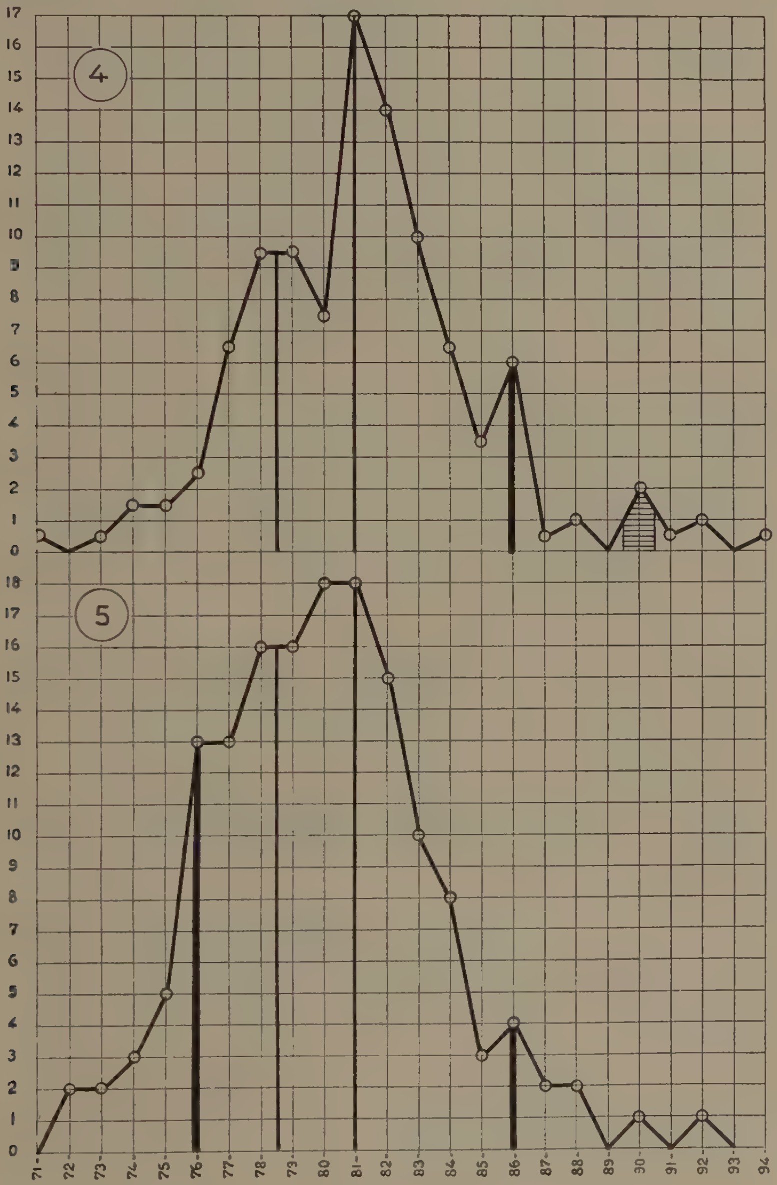
[1]) That in this group the 81 peak prevails over the 79 peak is curious considering the height of the 79 peak with the younger boys.

[2]) These Proceedings. Vol. 38, N⁰. 9, 1935.



Résumé.

Resuming our results we may state that the developmental changes of the index with the Askenasim Jews of Amsterdam is such that the so-called Central-Asiatic indices (83 and 86), quite outstanding in the children, decrease in number and the so-called paleo-Asiatic indices (78—79 and 81), though also present in childhood, increase with age. This phenomenon,

especially evident with boys, may be also observed in the females, although the infantile indices show a greater tendency to persist in this sex.

It furthermore appears that the Mediterranean 76 index becomes pronounced only with adults, being also preceded in childhood by a higher index.

Zoology. — *Die Tornarien der Snelliusexpedition.* Von G. STIASNY. (Rijksmuseum van Natuurlijke Historie, Leiden.) (Communicated by Prof. H. F. NIERSTRASZ).

(Communicated at the meeting of October 26, 1935).

In den Planktonfängen der Snelliusexpedition fanden sich folgende Tornarien:

Stat. 300. Südl. von Mindanao, Straminpose, 200 m wire, 22. Juni 1930.
1 Ex. vom Typus I (*Balanoglossus/Glossobalanus*), nicht tentakulat, Krohn/Spengel-Stadium. Stark contrahiert, Details nicht erkennbar, 2½ mm hoch. In der Mitte stark eingeschnürt, Analfeld stark vorgewölbt, undurchsichtig. Nicht näher bestimmbar.

Stat. 199. Südl. von Saleyer, Straminpose, 200 m wire, 5. Maart 1930.
4 Ex. *Tornaria snelliusi*, ältere Krohnstadien; schlecht erhalten.

Stat. 275. Nordöstlich von Halmahera, Straminpose, 50 m wire, 25. Mei 1930. 21 uur.
2 Ex. *Tornaria snelliusi*, ältere Krohnstadien, stark geschrumpft.

Stat. 310. Straat v. Makassar, Straminpose, 200 m wire, 5. Juli 1930. 21,15—21,45 uur.
1 Ex. *T. snelliusi*, junges Krohnstadium, ± 2 mm hoch, gut erhalten. Nur Rumpfcoelom vorhanden. Analfeld flach. Laterallobus mit nur 8 Tentakeln, davon einige ziemlich lang.

Stat. 241. Bandasee, Nordöstlich von Timor, Straminpose, 200 m wire, 12. April 1930.
214 Ex. *T. Snelliusi*, davon:
10 Metschnikoff-Stadien,
25 junge Krohnstadien,
142 ältere Krohnstadien,
37 Spengelstadien,
meist stark deformiert, die jüngeren Stadien sehr durchsichtig.

Stat. 210. Südl. von Boeroe, Straminpose, 200 m wire, 14. Maart 1930.
17 Ex. *T. snelliusi*, davon:
9 jüngere Krohnstadien,
8 ältere Krohnstadien.

Stat. 199. Südl. von Saleyer, Straminpose, 200 m wire, 5. Maart 1930.
70 Ex. *T. snelliusi*, davon:
9 Metschnikoffstadien,
12 jüngere Krohnstadien,
38 ältere Krohnstadien,
11 Spengelstadien.

Stat. 67. Nördl. vom Soeloe Archipel, Pearlbank, 200 m wire, 8. Sept. 1929.
2 Ex. *T. snelliusi*, ältere Krohnstadien, stark geschrumpft.

Stat. 80. Südl. von Halmahera, Straminpose, als Vertikalnetz, 4000—0 m, 30. Sept. 1929.
1 Ex. *T. snelliusi*, Agassizstadium. (Textfig. 5.) Genauere Beschreibung sieh unten.

Stat. 268. Südl. von Mindanao, Straminpose, 100 m wire, 19. Mei 1930, 21—21,30 uur.
1 Ex. *T. sunieri*, älteres Krohnstadium. Beschreibung sieh unten.

Stat. 222. Nordwestl. von Boeroe, Straminpose, 300 m wire, 22. Maart 1930.
3 Ex. *T. snelliusi*, ältere Krohnstadien, schlecht erhalten.

Stat. 192. Südl. von Celebes, Straminpose, 2000—0 m wire, 16. Feb. 1930.
1 Ex. *T. snelliusi*, älteres Krohnstadium, geschrumpft.

Stat. 230. Südl. von Bandasee, Westl. von Tenimber Eilanden, 600 m wire, 9. Apr. 1930.
2 Ex. *T. snelliusi* u. z.:
1 jüngeres Krohnstadium,
1 älteres Krohnstadium.
Das letztere gut erhalten, 5 mm hoch, zirkulärer Wimperkranz als eine breite Krämpe abstehend, Eichelcoelom sehr gross, Anlage des dorsalen und ventralen Nervenstranges sichtbar.

Stat. 212. Zwischen Boeroe und Celebes, Straminpose als Vertikalnetz, 4800—0 m, 15. Maart 1930.
1 Ex. *T. snelliusi*, älteres Krohnstadium, 4 mm hoch, mit sehr kurzen dichtstehenden Tentakeln.

Stat. 66. Nördl. vom Soeloe Archipel, Straminpose als Vertikalnetz, 3000—0 m, 7. September 1929.
1 Ex. *T. snelliusi*, älteres Krohnstadium, gut erhalten. ± 3 mm hoch, obere ventrale und dorsale Loben sackförmig, nicht gegabelt. Laterallobus mit nur 8 Tentakeln, ziemlich spitzem, dorsalwärts gerichtetem Lateralsattel; kein unterer Dorsallobus. Analfeld flach mit sekundärem Wimperring. Beide Coelome vorhanden, aber schwach entwickelt. Anlage des dorsalen und ventralen Nervenstranges deutlich sichtbar, auch auf dem Analfelde. (Sehr klein, Laterallobus und Sattel abweichend; sieh unten.)

Stat. 222. Nördl. von Boeroe, Straminpose, 300 m wire, 22. Maart 1930.
10 Ex. *T. snelliusi* ältere Krohnstadien, nur mässig erhalten.

Stat. 154. Südl. von Flores, zwischen Soemba und Timor, Straminpose, 200 m wire, 9. Dec. 1929.

1 Ex. *Tornaria* spec. (Textfig. 6), älteres Krohnstadium etwas deformiert. Beschreibung sieh unten.

1 Ex. *T. snelliusi*, junges Krohnstadium, ± 3 mm hoch und breit.

Stat. 299. Nördl. v. Boeroe, Straminpose, 200 m wire, 5. April 1930.

10 Ex. *T. snelliusi*, davon:

8 ältere Krohnstadien mit sehr dünnen, kurzen, dicht stehenden Tentakelchen, obere Loben nicht stets gegabelt. Analfeld bei einzelnen Ex. sehr stark kegelförmig vorgewölbt. Manche sehr gut erhalten.

2 Spengelstadien, geschrumpft, undurchsichtig.

Stat. 175. Balisee, Südl. von Lombok, Straminpose als Vertikalnetz, 2000—0 m, 31. Jan. 1930.

1 Ex. *T. snelliusi*, sehr gut erhalten, jüngeres Krohnstadium, als Type gewählt. (Textfig. 1—4). Beschreibung sieh unten.

Stat. 181. Nördwestlich von Flores, Straminpose, 300 m wir, 6. Febr. 1930.

5 Ex. *T. snelliusi*, ältere Krohnstadien.

Obere Loben schwach oder nicht gegabelt, ein Ex. mit stark vorgewölbtem Analfelde. Dorsaler Nervenstrang sichtbar.

Stat. 234. Bandasee, Südl. von Ceram, Straminpose, 300 m wire, 8. April 1930.

2 Ex. *T. snelliusi*, ältere Krohnstadien, schlecht erhalten.

Stat. 259. Westl. von Obi Major, Soeloe Arch., Straminpose, 300 m wire, 11. Mei 1930.

1 Ex. Tornaria vom Typus 1 (*Balanoglossus/Glossobalanus*), nicht tentakulat, nicht näher erkennbar, schlecht erhalten. Krohnstadium?

Stat. 248. Bandasee, Westl. von Toekang besi eilanden, Straminpose, 200 m wire, 16. Sept. 1929.

2 Ex. *T. snelliusi*, ältere Krohnstadien, schlecht erhalten.

Tornaria snelliusi nov. spec.

(Textfig. 1—4.)

Als Typenexemplar wähle ich das schöne, vortrefflich erhaltene Exemplar von Stat. 175, Balisee, südl. von Lombok, 2000—0 m wire. Es ist ein junges Krohnstadium mit nur peripherem Rumpfcoelom.

Grösse: 5½ mm breit und hoch. *Ptychoder*atypus. Grosse, plumpe Form, tentakulat, mit zirka 20—22 meist kurzen, dünnen Tentakeln an jeder Seite der oberen primären Loben. Die apikale Hälfte ein wenig über den zirkulären Wimperkranz überhängend. Analfeld ein flacher Kegel. Sekundärer Wimperring als ein dünner, heller Ring auf dem Analfelde sichtbar in unmittelbarer Nähe des zirkulären Wimperkranzes. Scheitelplatte nicht eingezogen. Augen ganz schwach sichtbar.

Ventralansicht: (Textfig. 1) Die tiefen primären Loben endigen breit gabelförmig. Ventralsattel hoch und schmal, mit keilförmig sich verjüngender Anlage des ventralen Nervenstranges. Ventralband sehr schmal.

Dorsalansicht: (Textfig. 2) primäre obere Loben gabelig endigend. Keine unteren dorsalen Loben. Dorsalporus tief in einer Nische liegend, unterhalb der Körpermitte. Dorsalband schmal.

Tornaria snelliusi nov. spec.

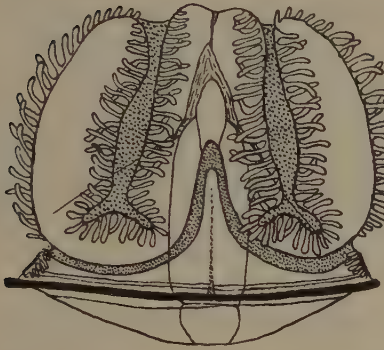


Abb. 1. Ventralansicht des Krohnstadiums

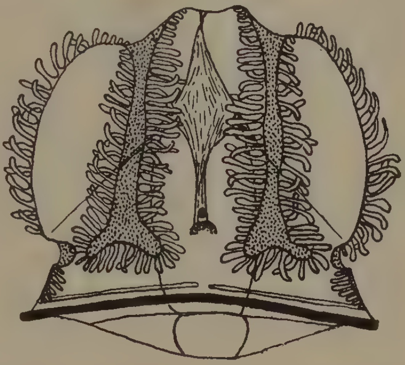


Abb. 2. Dorsalansicht des Krohnstadiums

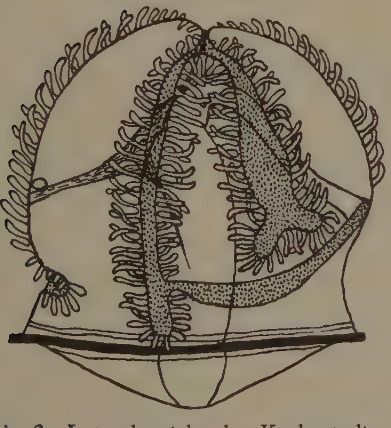


Abb. 3. Lateralansicht des Krohnstadiums

Abb. 4. Habitusbild des Krohnstadiums (Photographie)

Lateralansicht: (Textfig. 3) Laterallobus gut ausgebildet, eine tiefe Bucht, in der Richtung der Längsachse, nicht schräg liegend, mit 10—12 langen dünnen Tentakelchen. Lateralsattel flach. Kein unterer Dorsallobus vorhanden.

Innere Anatomie: schlanker, cylindrischer Magen, gestreckt. Oesophagus stark abgebogen, dünn. Enddarm ein kurzer Kegel. Eichelcoelom schmal, muskulös, auf dem Oesophagus reitend mit 2 langen dünnen Spornen, die stellenweise knotenförmig verdickt sind. Sie ziehen in der

Richtung der Lateralloben und scheinen frei zu endigen. Nur das Rumpfcoelom ausgebildet in Form eines langen dünnen Ringes, dessen schmale Öffnung unterhalb des Hydroporus liegt. Herzblase peripher, oberhalb des Hydroporus, Rüsseldrüse noch nicht entwickelt.

Diagnose: *Ptychodera*typus. Grösse 5½ mm (vielleicht noch etwas grösser), 20 bis 22 meist kurze, dichtstehende Tentakelchen an den meist gabelig endigenden primären Loben. Ventralsattel hoch und schmal. Laterallobus tief, in Längsachse orientiert mit 10—12 Tentakelchen, ohne vorspringenden Lateralsattel. Kein unterer Dorsallobus. Analfeld kegelförmig. Ventral- und Dorsalband schmal. Hydrocoel mit Spornen. Malaischer Archipel (Osthälfte).

Hauptmerkmale: hoher Ventralsattel. Lateralsattel mit 10—12 Tentakelchen ohne vorspringenden Lateralsattel. Kein unterer Dorsallobus.

Metschnikoffstadium: 2½—3 mm hoch, meist ganz durchsichtig. Analfeld flach. Am Laterallobus nur wenige kurze und einige längere Tentakelchen, nie mehr als 8. Sporne ganz kurz.

Jüngere Krohnstadien: 3½—4 mm hoch. Das Ex. von Stat. 175 ist ungewöhnlich gross (5½ mm).

Ältere Krohnstadien: 4—5 mm hoch, Kragencoelom weit entfernt vom Rumpfcoelom. Sporne kurz, blind endigend, durchsichtig.

Spengelstadien: 4½ mm hoch, undurchsichtig, mit dickem Epithel. Tentakel stellenweise reduziert, Analfeld vorgewölbt. Hydrocoel ein dicker, plumper Sack mit langen Spornen.

Agassizstadium: von Stat. 80 (Textfig. 5).

4½ mm hoch, apikale Hälfte keulenförmig verdickt. Epithel stellenweise abgefallen; nur auf der Dorsalseite und dem Analfeld ist ein breiter Streifen davon übrig geblieben, daher der apikale Teil fast ganz durchsichtig. Schwache Spuren der Tentakelchen an den nicht gabelig endigenden oberen Loben. Hoher, schmaler Ventralsattel. Am Laterallobus 10—12 Tentakelchen, gut ausgebildet. Analfeld ein flacher Kegel. Darm schlank, analwärts verschoben; Oesophagus sehr stark winkelig abgeknickt. Das Eichelcoelom ist ein sehr grosser, muskulöser, dickwandiger Sack, mit zahlreichen, parallel verlaufenden, seitlich deutlich vorspringenden Querfalten. Kurzer Ausführungsgang. Sporne schwach ausgebildet(?) Herzblase und Rüsseldrüse gross, tiefliegend. Rumpf und Kragencoelome kräftig entwickelt, weit von einander entfernt liegend. Ventraler Nervenstrang auch auf dem Analfelde gut verfolgbar, dorsaler dagegen undeutlich.

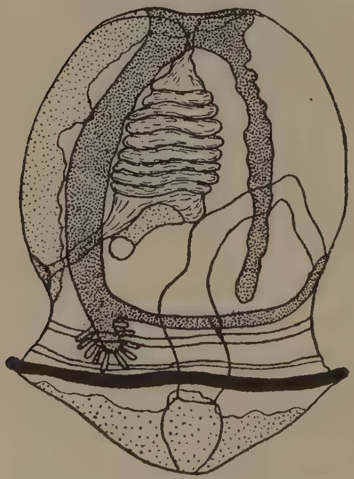


Abb. 5. Lateralansicht des Agassizstadiums.

Die Zugehörigkeit dieser Larve zu *T. snelliusi* lässt sich nur schliessen aus dem übereinstimmend gebauten Laterallobus.

Das ältere Krohnstadium von Stat. 66 weicht in mancher Hinsicht von den übrigen gleichaltrigen Stadien der *T. snelliusi* ab. Es ist gut erhalten, fast nicht deformiert ± 3 mm hoch, also ziemlich klein. Die oberen ventralen und dorsalen Loben sind sackförmig, nicht gegabelt. Laterallobus mit nur 8 Tentakeln und ziemlich spitzem dorsalwärts gerichteten Lateralsattel. Kein unterer Dorsallobus, oder, wenn vorhanden, nur ganz kurz. Analfeld flach, mit secundärem Wimperkranz. Anlage des dorsalen und ventralen Nervenstranges deutlich sichtbar, auch auf dem Analfelde. Kurze Sporne des Eichelcoeloms. Beide Coelome vorhanden, aber schwach entwickelt.

Auffallend ist hier die geringe Grösse, Sackform der primären oberen Loben und die Form des Laterallobus mit 8 Tentakeln und ziemlich spitzem Lateralsattel. Trotz dieser Abweichungen halte ich die Larve für zugehörig an *T. snelliusi*, weil auch die übrigen Exemplare, wenn auch nicht so stark, in Bezug auf das eine oder andrere Merkmal variieren.

Nur das eine Exemplar von Stat. 175 ist so schön erhalten, die meisten übrigen sind mehr oder minder verunstaltet. Es ist ein kugeliges Bläschen (Textfig. 4) mit vollem Turgor, und zeigt alle Merkmale in voller Deutlichkeit.

Variationen. Grösse. Alle anderen Larven sind viel kleiner. Das ältere Krohnstadium von Stat. 66 ist nur ± 3 mm hoch (?) Aber auch das grosse Typenexemplar dürfte volle Grösse nicht erlangt haben (5½ mm), da es sich ja erst im jüngeren Krohnstadium befindet (Nur Rumpfcoelom vorhanden).

Die Tentakel sind bei manchen Exemplaren im älteren Krohnstadium auffallend klein und dünn und stehen sehr dicht. Beim Typenexemplar zeigen sie normale Grösse. Ihre Zahl ist ziemlich konstant. Mehr als 24 Tentakel habe ich nie gezählt.

Die oberen primären Loben endigen manchmal als blinde, runde Säcke, nicht gabelig oder die Gabelung ist nur sehr schwach angedeutet. In meiner Übersichtstabelle II (1934) habe ich Sackform und Gabelung noch als gute Merkmale betrachtet, was jetzt kaum mehr als zulässig erscheint.

Der Laterallobus hat in manchen Fällen nicht die normale Tentakelanzahl, sondern weniger (± 8), auch sind einzelne Tentakel auffallend lang.

Bei dem Krohnstadium von Stat. 66 ist der Lateralsattel ziemlich spitz, sonst ist er stets flach.

Der zirkuläre Wimperkranz sitzt manchmal auf einer sehr breiten Krämpe und wird dadurch sehr auffallend.

Das Analfeld ist öfters ganz flach, der sekundäre Wimperkranz bald sichtbar, bald nicht.

Die Anlagen der Nervenstränge lassen sich in manchen Fällen bis auf das Analfeld verfolgen, in anderen nicht.

Warum ist *Tornaria snelliusi* species nova?

Bei einem Vergleiche mit den anderen sogenannten guten Arten des Typus *Ptychodera*, zu dem wir die Übersichtstabelle II (1934) heranziehen, ergibt sich Folgendes:

Da bei *T. snelliusi* der Laterallobus 10—12 Tentakel trägt, kommen von den 7 bekannten Arten nur 4 in Betracht:

willeyi: Mit dieser nur im Agassizstadium bekannten Art kann man natürlich nur das Agassizstadium von Stat. 80 vergleichen. *T. willeyi* ist viel grösser (6 mm), der Ventralsattel ist spitz und kurz. Fundort: Neu Guinea. Beide Formen zeigen grosse Ähnlichkeit! Ich halte Identität beider Stadien für sehr gut möglich.

chierchiai: ist etwas kleiner, (4½ mm), Laterallobus mit nur 8 Tentakel; flaches Analfeld, langer unterer Dorsallobus ohne Tentakel.

morgani: ist kleiner, (4½ mm), hoher, spitzer, dorsalwärts gerichteter Lateralsattel des schräg liegenden Laterallobus mit 10 (?) Tentakeln. Ventralsattel? (sieh meine Ausf. 1934, p. 15).

uchidai: flacher, niedriger Ventralsattel und kurzer unterer Dorsallobus. Daraus ergibt sich das *T. snelliusi* eine neue Art ist und im Krohnstadium der *T. uchidai* aus dem Pacific am nächsten steht.

Tornaria spec. valde affinis morgani Stiasny.

(Textfig. 6).

Von Stat. 154, zusammen mit 1 Ex. von *T. snelliusi*.

Älteres Krohnstadium, ± 4 mm hoch, und breit. *Ptychoderatypus*. Hoher Ventralsattel, grosser, schräg liegender Laterallobus mit hohem spitzigen Lateralsattel u. mit ± 16 Tentakeln, ganz ähnlich wie bei *Tornaria morgani* Stiasny von Westindien. Tentakel ziemlich lang. Breiter, unterer Dorsallobus. Rumpf- und Kragencoelom vorhanden. Herzblase tiefliegend, weit entfernt vom Eichelporus. Eichelcoelom mit kurzen Spornen.

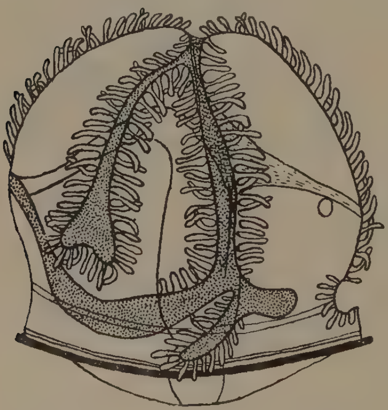


Abb. 6. *Tornaria* spec. valde aff. *morgani* Stiasny. Lateralansicht.

Diese Tornaria steht der *T. morgani* durch den ganz übereinstimmenden Bau des Laterallobus und Lateralsattels nahe, unterscheidet sich aber von ihr durch den breiten unteren Dorsallobus, der bei *morgani* fehlt. Man müsste sie als eine neue Art bezeichnen. Da aber nur ein einziges nicht tadellos erhaltenes Exemplar vorliegt, sehe ich von Aufstellung einer solchen ab.

Tornaria sunieri Stiasny.

Das Exemplar von Stat. 268 ist ein älteres Krohnstadium, stark verunreinigt, ± 2 mm hoch, 2½ mm breit. Zirkulärer Wimperkranz auf breiter Krämpe aufsitzend, Analfeld vorgewölbt. An der geringen Grösse, dem hohen, schmalen Ventralsattel, dem breiten, flaschenförmigen Laterallobus ohne Tentakel und den beiden, dem Darme dicht anliegenden Coelomen sofort erkennbar. Anlage des Nervenstänge auch auf dem Analfeld angedeutet.

Tornarien des Balanoglossus/Glossobalanus-Typus.

Es ist ungemein bedauerlich, dass beide vorliegenden tentakellosen Tornarien des Typus I von Stat. 259 und 300 in so schlechtem Erhaltungszustande sind, dass man sie nicht näher analysieren kann. Larven dieses Typus sind ja bisher im Archipel noch nicht nachgewiesen, eine adulte Art aber wohl (*Glossobalanus rufficollis* (Willey)). Beide Larven sind im Krohn- oder Krohnspengel-Stadium. Mehr lässt sich über dieselben kaum sagen.

Im Ganzen fanden sich in den Fängen der Snelliusexpedition 355 Exemplare von Tornarien. Das ist eine reiche Ausbeute im Vergleich zu den Fangergebnissen der Sibogaexpedition, da von dieser nur einige („eine Anzahl") Enteropneustenlarven gefischt wurden. Von den 355 Exemplaren entfallen 351 auf *Tornaria snelliusi*, 1 Ex. auf *T. sunieri*, 1 Ex. wurde als *Tornaria* spec. valde aff. *morgani* bezeichnet, 2 nicht tentakulate Tornarien, die nicht näher bestimmbar waren, gehören zum Typus *Balanoglossus/Glossobalanus*. Das Tornarienmaterial der Snelliusexpedition muss daher als sehr monoton bezeichnet werden, da die weitaus grösste Anzahl einer einzigen Art angehört. Es ist eine dem *Ptychodera*-typus angehörende Form, die sich von den übrigen bekannten Arten dieses Typus durch einige Merkmale deutlich unterscheidet.

Manche Fänge (von Stat. 199 und 241) enthalten eine überaus grosse Anzahl von Larven in verschiedenen Entwicklungsstadien: es sind geradezu Massenfänge mit 70 resp. 214 Exemplaren. Da dieselben nicht gleichaltrig sind, konnte auch die Entwicklung ein wenig untersucht werden.

Der Erhaltungszustand der meisten Larven ist leider kein besonders guter (Formolkonservierung der ganzen Planktonfänge), sodass die Untersuchung dadurch sehr erschwert war und derselben enge Grenzen gezogen wurde. Nur das Typenexemplar von *T. snelliusi* ist ganz ungewöhnlich gut erhalten und zeigt deutlich, wie Tornarien eigentlich aussehen, wenn sie zufälligerweise gut konserviert sind. Man muss sie eben gleich nach dem Fange herausholen und einzeln konservieren, worauf ich schon bei früherer Gelegenheit dringend hingewiesen habe (1934, p. 15).

Die meisten Exemplare stammen von Oberflächenfängen, die ziemlich gleichmässig über das Untersuchungsgebiet verteilt sind. Doch liegen auch

Exemplare vor aus Tiefenfängen, bei denen das Netz (Straminpose) als Vertikalnetz gebraucht wurde, aus 2000—0 m (Stat. 175), 3000—0 m (Stat. 66), 4000—0 m (Stat. 80) und 4800—0 m (Stat. 212). Es sind dies jedoch keine Schliessnetzfänge, sodass man nicht mit einiger Sicherheit wissen kann, aus welchem Tiefenhorizonte die betreffenden Exemplare stammen. Immerhin entstammt aber das Agassizstadium von Stat. 80 einem derartigen Tiefenfange. Die meisten Exemplare sind wohl erst im letzten Augenblicke des Fanges ins Netz geraten und stammen von der Oberfläche.

Die Tornarien der Snelliusexpedition sind trotz ihres meist schlechten Erhaltungszustandes und der Monotonie des Materiales aus mehreren Gründen interessant. Weniger darum, weil wieder eine neue Art (*snelliusi*), darin enthalten ist, sondern, weil ganz andere Larventypen gefangen wurden, als nach den bisherigen Erfahrungen zu erwarten war. Die Snelliusexpedition arbeitete in der östlichen Hälfte des malayischen Archipels. Das ist ein Teil des Reiches der *Spengelia*-Arten (van der Horst, 1934, p. 396, Fig. 451 und Stiasny-Wijnhoff und Stiasny, 1927, p. 199/200, Karte 2). Zu erwarten gewesen wären also in erster Linie Larven des *Spengelia* Typus (klein, tentakulat, Coelome dem Darme anliegend). Von diesen wurde jedoch nur ein einziges Exemplar (*Tornaria sunieri*), auf Stat. 268 (östl. v. Mindanao), erbeutet.

Das Gros der gefangenen Enteropneustenlarven gehört jedoch dem Typus *Ptychodera* an (gross, tentakulat, peripher liegende Coelome) und das Genus *Ptychodera* ist im adulten Zustande bisher im Archipel noch gar nicht nachgewiesen! (Stiasny-Wijnhoff und Stiasny, p. 198). Zwei schlecht erhaltene, nicht tentakulate Tornarien konnten nur als dem Tornarientypus I (*Balanoglossus*/*Glossobalanus*) zugehörig erkannt werden.

Im malayischen Archipel waren insgesammt bisher 3 verschiedene Tornarien nachgewiesen:

Tornaria spengeli Stiasny d.i. *T. sibogae* von Spengel.	Siboga Stat. 144, 165, 185, Molukken, zwischen Damar und Mysol (Spengel, p. 123)	„eine Anzahl"
Tornaria delsmanni Stiasny-Wijnhoff und Stiasny d.i. „die Tornaria von Madoera",	Strasse von Madoera, bei Soerabaya	28 Ex.
Tornaria sunieri Stiasny	Javasee, zwischen Cheribon und Semarang . .	50 „

Und jetzt kommen noch hinzu die Tornarien der Snelliusexpedition:

Tornaria snelliusi Stiasny	von vielen Stat. im östl. Teil des Archipels . .	355 „
Tornaria spec. valde aff. *morgani* Stiasny	südl. Flores, zwischen Soemba und Timor	1 „
Tornaria spec. des Typus I	südl. Mindahao und westl. Obi Major	2 „

Davon gehören *Tornaria spengeli, delsmanni* und *sunieri* zum *Spengelia* Typus; *T. snelliusi* und *T. spec. morgani valde aff.* zum *Ptychodera* Typus und T. spec. zum Typus *Balanoglossus/Glossobalanus.*

Von adulten Enteropneusten kennt man aus dem Archipel:

Spengelia sibogae Spengel,
Spengelia amboinensis Spengel,
Glandiceps malayanus Spengel,
Glossobalanus ruficollis (Willey).

Wir kennen also aus dem Archipel zwei Arten adulter Enteropneusten des Genus *Spengelia* (*sibogae* und *amboinensis*) und drei Larven des Typus *Spengelia* (*spengeli, delsmanni, sunieri*); eine Art des Genus *Glossobalanus* und eine Tornaria des Typus I; und eine *Glandiceps*art (*malayanus*), aber keine Tornaria des Typus *Glandiceps.*

Daraus ergibt sich Folgendes:

I.) Im Archipel ist höchstwahrscheinlich noch eine bisher unbekannte Art adulter Tiere des Genus *Spengelia* vorhanden.

II.) Es muss im Plankton des Archipels noch eine Tornaria des *Glandiceps*typus zu finden sein.

III.) Mit grosser Wahrscheinlichkeit lässt sich voraussagen, dass das Genus *Ptychodera* auch im ostindischen Archipel vorhanden und daselbst keineswegs selten sein muss. Man wird mit der Annahme nicht sehr fehl gehen, dass auch im Archipel die in den pacifischen Gewässern so häufige und auch im Indic nachgewiesene *Ptychodera flava* Eschscholz vorhanden ist; ja vielleicht noch eine zweite Art des Genus *Ptychodera*!

Vor kurzem habe ich (1934) eine Übersicht der bekannten Tornarien des *Ptychodera*typus gegeben und auf die geringfügigen Unterschiede der sogenannten guten Arten diese Typus hingewiesen. Ich habe dabei auch die Frage erörtert, ob man überhaupt noch berechtigt ist, von verschiedenen Arten zu sprechen. Das abschreckende Beispiel SPENGELS warnt jedoch andrerseits, alle immerhin doch unterscheidbaren Formen unter einen Hut zu bringen. Nur mit Widerstreben habe ich daher *T. snelliusi* als eine neue Art beschrieben; lediglich um konsequent zu bleiben. Ich konnte hier, da reichliches Material vorlag, die Variationsbreite dieser Form näher untersuchen. Leichterdings hätte ich noch eine zweite, ja event. sogar noch eine dritte neue Art aufstellen können. Das schien mir aber doch etwas zu stark, denn im untersuchten Gebiet ist ja überhaupt keine *Ptychodera,* in den angrenzenden pacifischen Gewässern nur die einzige adulte *Ptychodera flava* Esch. bekannt. Auf die grosse Variationsbreite dieser adulten Form haben VAN DER HORST, TREWAWAS, PUNNETT und ich hingewiesen. Auf die Publikation von VAN DER HORST (1932), die ich versehentlich in meiner Diskussion (1934) nicht berücksichtigt habe, mache ich hier noch besonders aufmerksam. Dass auch die Larven sehr variabel sind, wird durch die vorliegende Untersuchung aufs neue bestätigt.

Man muss eben noch im Archipel nach adulten Enteropneusten und Tornarien suchen. Es ist darüber noch lange nicht das letzte Wort gesprochen!

LITERATURVERZEICHNIS.

HORST, C. J. VAN DER, 1932, Die Enteropneusten-Gattung *Ptychodera*. Zoolog. Anz. Bd. **39**.

———— 1934, H. G. Bronn's Klassen und Ordnungen des Tierreiches. Bd. **4**. Vermes. IV. Tentaculata, Chaethognatha und Enteropneusta. **3**. Lief.

SPENGEL, J. W., 1907, Studien über die Enteropneusten der Sibogaexpedition. XXVI. Monogr. Leiden.

STIASNY, G., 1921, Eine neue Tornaria aus dem ostindischen Archipel (*Tornaria sunieri*). Zoolog. Mededeel. Rijksmus. Nat. Hist. Leiden. Deel VI.

———— 1934, Über einige exotische Tornarien. Verh. Kon. Akad. Wetenschappen, Amsterdam. Afd. Natuurk. 2. Sect. Deel XXXIV, No. 2.

STIASNY-WIJNHOFF, G. und STIASNY, G., 1927, Die Tornarien. Kritik der Beschreibungen und Vergleich sämmtlicher bekannter Enteropneustenlarven. Ergeb. u. Fortschr. Zoologie, Bd. **7**.

TREWAVAS, E., 1934, Enteropneusta. Great Barrier Reef Expedition 1928—1929. Scient. Rep. Vol. IV.

Die angewendeten Termini technici der Larventypen, Altersstadien, Teile der Wimperschnüre, Körperregionen, der inneren Anatomie, etc. wurden hier um unnötige Wiederholungen zu vermeiden, nicht näher erklärt.

Ich muss diesbezüglich auf unsere Revision (1927) und meine Arbeit (1934) verweisen.

Comparative Physiology. — *Tonus phenomena in the foot of the snail (Helix pomatia)*. By N. POSTMA. (From the Laboratory of comparative Physiology of the University of Utrecht). (Communicated by Prof. H. J. JORDAN).

(Communicated at the meeting of October 26, 1935).

Introduction.

In smooth muscle there is no constant relation between initial length and tension. When a weight is applied to plain muscle, a long-lasting extension (of an hour or more) follows, till in most cases an approximately constant length is reached. After unloading, a great part of the extension is irreversible. Therefore the tonus of unstriated muscle is measured as a resistance of its substance to extension by recording length (ordinate)-time (abscissa)-curves with the aid of a level and a kymograph (cf. JORDAN). From the snail's foot (ganglia extirpated) we obtain after loading a short stretch of rapid extension, followed by a second phase during which the length increases continuously, the time rate diminishing as the extension proceeds, just as of some plastic inanimate materials (cf. JORDAN 1935*b*). Since the resistance diminishes at higher temperatures, JORDAN has spoken of phenomena of *viscosoid tone*. Subject of his studies were invertebrate-smooth-muscles, which resemble our cavern organs (stomach, bladder, etc.).

New investigations, especially on the snail's foot muscle, made it seem useful to distinguish *tonus plane* (= degree of shortening or length of muscle maintained by the tone, independent of the resistance offered) and *tonus level* (= the measure of resistance, independent of muscle-length).

JORDAN, failing to restore the original length and resistance by stimulating the foot muscle, nerves or centres, limited his investigations to a comparison of the length-time curves of the non-stimulated muscle (so-called *rest curves*). Myograms obtained by motor contractions were also studied to get discrepancies between motor activity (tetanotone) and the viscosoid tonus.

The snail's foot muscle has a certain tonus level. On deviation from this level the foot tries to restore the original tonus level, which requires a comparatively long time ($\frac{1}{2}$—1 hour). The tonus level has to be considered (according to JORDAN 1935*a*) as an equilibrium between a *static* and a *dynamic component*, the former being a residuum of a contraction of the slow (or pseudomotor) system; that contraction is the dynamic component.

The static component shows a tendency to disappear extremely tardily, the dynamic one continually compensating the loss. The latter process being disturbed by cooling (35 min. after cooling set in, every resistance is absent in Aplysia) or by isolating the foot muscle from the intestinal sac (3 or 4 days after isolation there is no more resistance — KOSCHTOJANZ on Helix —, the loss of static tonus comes to light.

Static and dynamic components are discriminated from each other by the influence of temperature-alternations. If the foot is cooled for 35 minutes or less, the resistance to extension increases, while higher temperatures are unfavourable: so-called "old viscosity" or the static component. The dynamic component can be made active by heat (cf. also SCHULTZ): on cooling the Aplysia-foot for 35 minutes or more, the muscle becomes impotent to offer any resistance: the static component has disappeared. In this condition rise of temperature is followed by a contraction, and moreover by new resistance, which is immediately abolished, if the muscle is cooled again ("young viscosity" or the dynamic component): low temperatures completely annul the new tonus.

Besides the tonic state, which gives the foot muscle plastic properties (every loading causing an irreversible deformation, without producing enough tension to balance the weight), the snail's foot can show a state in which the foot bears a certain load for a longer or shorter interval of time: *bearing-tonus* (= "Konstanz" — JORDAN —). The extension myogram of this tonus phenomenon is typically different from that of the plastic reaction: the rapid extension-phase at the beginning covers a greater stretch, the course of the second part of the curves being approximately horizontal (bearing-tonus therefore); the transition from the steep part to the flatter portion is formed by a sudden bend. Thus these curves show a tendency to cross those of the form described before.

The forms of bearing-tonus we know, appearing under different circumstances, are:

peripherous bearing-tonus, i.e. constancy, all ganglia being extirpated;

central tonus, that is bearing-tonus in the presence of the pedalvisceral ganglia-mass. The latter reaction being different according to the load applied, we distinguish:

"Zentralkonstanz", on application of a relatively greater load;

"Muskelkonstanz", a small load being applied.

Technical notes.

Having succeeded in restoring original length and resistance (tonus plane and tonus level), we could study the so-called *repetition curves*. These curves being congruent, methods of quantitative comparison have been elaborated.

The lengthening-apparatus of VAN SWINDEREN was modified for the purpose of following the tonus phenomena at very low temperatures, if required introducing or removing ice-cooling.

The LUCAS-level was altered with a view to obtain a constant relation between muscle-length and ordinate-length over the whole recording-excursion of the level.

The course of the curves was characterized by angles in relation to definite intervals of time, measured (between a horizontal line and the tangent in points — marking the time-intervals — of the curves) by means of WENT's graduated arc.

Results.

As has already been mentioned, we have succeeded in realizing circumstances under which the stretched snail's foot restored both tonus plane and -level by a so-called tonic contraction evoked by an electric stimulus: every load and friction during the contraction had to be excluded. Thus the problem how the snail can alter its direction while creeping and afterwards restore its original form has been solved (cf. POSTMA 1934, p. 348). The restoration of tonus level is incomplete when the muscle, contracting, had to overcome any friction between level and myogram-paper. In this case, the repetition curves showed a specific alteration when the temperature was raised, quite different from that of rest curves and that of repetition curves with total restoration. In accordance with the rise of the temperature the initial part of the curves slopes much more rapidly (loss of the static component) than the rest curves. The slope of the second part of the repetition curves — in contrast with that of rest curves, which at higher temperature remain steeper over the whole length — diminishes with rising temperature, the transition being formed by a more sudden bend at higher temperatures (dynamic component) and the curves crossing those obtained at lower temperatures. If the second part is nearly horizontal, the foot is in peripherous bearing-tonus, a peculiar equilibrium between static and dynamic component, the static one being impaired and hyper compensated by the dynamic one.

The tonic contraction has — within reasonable intervals — no spontaneous relaxation: level nor plane are diminished at intervals at the top of the contraction. During extension, however, the internal condition of the foot muscle is altered (increased resistance), which alteration is reduced by unloading during a long interval (½—1 hour). This is found during rest curves as well as in repetition curves, independent of the complete or incomplete restoration of the muscle tone. In the latter case it was demonstrated that the dynamic component is activated, also causing increase of resistance if the temperature was raised during the interval of unloading.

The repetition curves of the foot muscle in possession of pedal ganglia are only congruent if a definite load — specific per test object — is applied: the so-called threshold load, probably in accordance with a threshold pressure existing in the animal. The constant tonus plane of this central tonus — and the plane of that in rest curves — depends primarily on the length of the foot, when the cerebral ganglia were extirpated (= *plate-length*, because the foot has been stretched a little to that length and then fixed on a wax plate, before the ganglia are cut away). The initial steep stretch is also maintained in the repetition curves: special influence of the pedal ganglia.

Every load larger or smaller than the threshold value alters the plane of bearing-tonus: a smaller load raises the plane ("Muskelkonstanz"), a larger one lowers it in the successive curves ("Zentralkonstanz"). In the first case there is a tendency to shorten the drop at the beginning, a sloping stretch forming the transition from the steep part to the horizontal. With loads larger than the threshold the foot inclines to strengthen the initial drop; the latter may be called into existence by using a larger load, if it be lacking in the rest curve.

Lowering of the "Zentralkonstanz"-plane is furthered at rising temperature. Heat prevents the alteration in "Muskelkonstanz"-plane; lowering of temperature does the same with respect to "Zentralkonstanz". Cooling, however, stimulates the rise of "Muskelkonstanz"-plane.

LITERATURE CITED:

1930. JORDAN, H. J. Der Tonus glatter Muskeln als Funktion der Muskelfluidität. Proc. Kon. Akad. v. Wetensch. Amsterdam **33**, 788—791.

1933. POSTMA, N. Recherches sur l'allongement du pied de l'escargot, etc. Ibid. **36**, 360—371.

KOSCHTOJANZ, CH. S. Zur Frage nach den Wechselbeziehungen zwischen Tonus und Tetanus in den glatten Muskeln von wirbellosen Tieren. Russ. Zeitschr. f. Biol. Tom. **2**, N⁰. 6, pp. 503—508.

1934. POSTMA, N. Interaction between viscous and tetanic functions in the foot of the snail (Helix Pomatia). Proc. Kon. Akad. v. Wetensch. Amsterdam **37**, 348—354.

1935a. JORDAN, H. J. Tonische Verkürzung und tonisches Festhalten der Verkürzung bei den Muskeln von Aplysia limacina unter Einfluss wechselnder Temperaturen. Ibid. **38**, 358—365.

b. ———— Viscosity effects in the living protoplasm and in muscles. First report on Viscosity and Plasticity, Chapter VI. Verhand. Kon. Akad. v. Wetensch. Amsterdam, afd. Natuurk. 1e sectie **15**, 214—255.

POSTMA, N. Onderzoekingen betreffende het herstel van de tonus bij de slakkevoet (Helix Pomatia L) door prikkeling en betreffende de invloed van het centrale zenuwstelsel daarop. Thesis at Utrecht.

Anatomy. — *Anatomical study of a case of unilateral section of the Bracchium conjunctivum cerebelli in the dog, with remarks concerning the existence of cerebellopetal fibres in this Bracchium.* By SVEN MAGNUS BERGGREN. (Communicated by Prof. C. WINKLER).

(Communicated at the meeting of October 26, 1935).

Through the great kindness of Prof. RADEMAKER I got the opportunity of studying the brain of a dog, in which a cut was made on the right side of the mesencephalon with the intention of cutting through the bracchium conjunctivum cerebelli. A fortnight after the operation the dog was killed and, under the kind directions of Prof. C. WINKLER in his laboratory, the brain was prepared with osmium after the method of MARCHI. Only the brain stem between the nucleus ruber and the decussatio pyramidorum was prepared.

The wound made by this operation reaches in frontal direction to the level of the frontal end of the corpus quadrigeminum posterius, where it has the character of a horizontal fissure placed dorsally from the lemniscus medialis. From here the cut runs in caudal direction, turning somewhat dorsally and extending to the middle line, and on its way it cuts through the bracchium conjunctivum and also other tracts, which will be described later. In the posterior part of the mesencephalon there is a small cut turning in ventral direction, which reaches the dorsal boundary of the lemniscus medialis and cuts through the tractus rubrospinalis. The cut leaves the mesencephalon just behind the corpus quadrigeminum posterius, but can be followed further into the cerebellum, running close to the bracchium conjunctivum and partly destroying the tractus uncinatus and the tractus GOWERS. Through a small channel this cut is connected with a destructed area comprising the anterior part of the nucleus globosus and touching the nucleus emboliformis in its anterio medial part. The cut may be traced in the schematic fig. 1 as well as in the figs. 2, 3 and 5.

Through the section of the bracchium conjunctivum there is a vast degeneration across Wernekinck's commissure towards the nucleus ruber on the opposite side (fig. 2). In the direction towards the cerebellum there are also black Marchi-grains spread over the field of the cut bracchium conjunctivum, and they can here be followed within the cerebellum. Some of the degenerated fibres from the field of Wernekinck's commissure are seen bending ventrally and taking a caudal course in the ventral part of the fasciculus praedorsalis. Partly these might represent the fibres branching off from the bracchium conjunctivum, which were first described by Marchi. The rest, however, must be regarded as fibres from the colliculus posterior, which are cut on their course through the tegmentum and, crossing the middle line among the fibres of the bracchium conjunctivum, take a caudal direction (tractus tectobulbaris). In their course there are in some sections found fibres bending ventrolaterally to the nuclei dorsales pontis (fig. 3). In conformity with the studies by Winkler also a few fibres are seen passing from the degenerated bracchium conjunctivum to the fasciculus longitudinalis posterior on the same side.

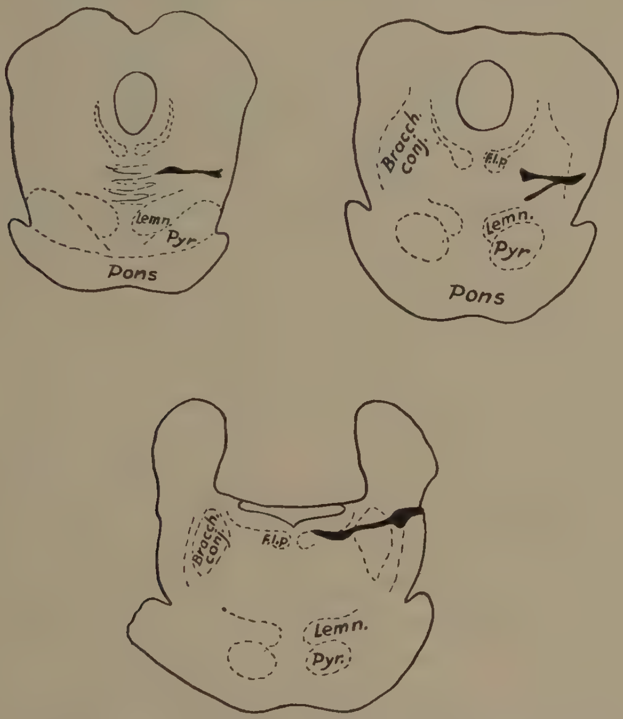


Fig. 1. Schematic sections, showing the operation-wound.

The lemniscus lateralis is cut just ventrally from the nucleus superior lemnisci, which causes a degeneration of not very great intensity within the colliculis posterior as well as along the acusticuspath to the nucleus ventralis lemnisci and the oliva superior (tractus tectopontinus and tectoreticularis).

In its dorsal turning the cut crosses the fibres of the tractus centralis tegmenti as well as the dorsolateral part of the fasciculus praedorsalis and longitudinalis posterior and the whole of the tractus vestibulo-mesencephalicus and the radix ascendens nervi V. Hereby there is a rather intense degeneration in frontal direction of the dorsolateral part of the tractus centralis tegmenti, while in caudal direction only a few degenerated fibres are seen in its field. On the level of the caudal end of the colliculus posterior degenerated fibres from this field are seen bending ventrally and passing through the formatio reticularis to the medial boundary of the superior olive, from where they can be followed to the inferior olive, gradually somewhat decreasing in number. A few of these fibres continue their caudal course in the field of the tractus olivospinalis. The fasciculus praedorsalis shows a rather extensive degeneration in caudal direction, growing less on its way through the medulla oblongata but still quite evident in the very frontal part of the medulla spinalis (fig. 6). The fasciculus longitudinalis posterior too contains MARCHI-grains in its lateral part in both frontal and caudal direction. In caudal direction, where they can be followed, they soon diminish in number and beyond the middle of the medulla oblongata there are hardly any left, except those which have been displaced ventrally to the field of the fasciculus praedorsalis. The tractus vestibulo-mesencephalicus is degenerated in frontal direction. The section of the radix mesencephalicus nervi V causes a massive degeneration of the radix motorius of this nerve. Some of the degenerated fibres, however, do not leave the brain but end in the caudal part of the nucleus motorius masticatorius (fig. 4), and a few take a caudal course along the mediodorsal corner of the nucleus sensorius nervi V where they can be followed to the caudal part of the medulla oblongata.

The cut through the tractus rubrospinalis causes a strong degeneration in the field of this bundle, which can be distinctly traced to the very frontal part of the medulla spinalis, where the series ends (figs. 2, 3, 4 and 6).

The cut made by the operation has at its frontal end wounded the lateral part of the lemniscus medialis, thus causing a degeneration in frontal direction in the field medially from the corpus geniculatum mediale.

A distinct degeneration is found in the right pedunculus corporis mamillaris, caudally losing itself in the field between the lemniscus medialis and the formatio reticularis. Degenerated fibres also are found in the right pes pedunculi, most of which end in the ponsnuclei. In the latter cases the origin of the degeneration could not be stated.

Within the cerebellum a degeneration is found of the medulla in its mediofrontal part on the right side, and only few fibres pass the middle line. The destroyed area around the nucleus globosus causes a rather extensive degeneration of the tractus uncinatus on either side. Also among

SVEN MAGNUS BERGGREN: ANATOMICAL STUDY OF A CASE OF UNILATERAL SECTION OF THE BRACCHIUM CONJUNCTIVUM CEREBELLI IN THE DOG, WITH REMARKS CONCERNING THE EXISTENCE OF CEREBELLOPETAL FIBRES IN THIS BRACCHIUM.

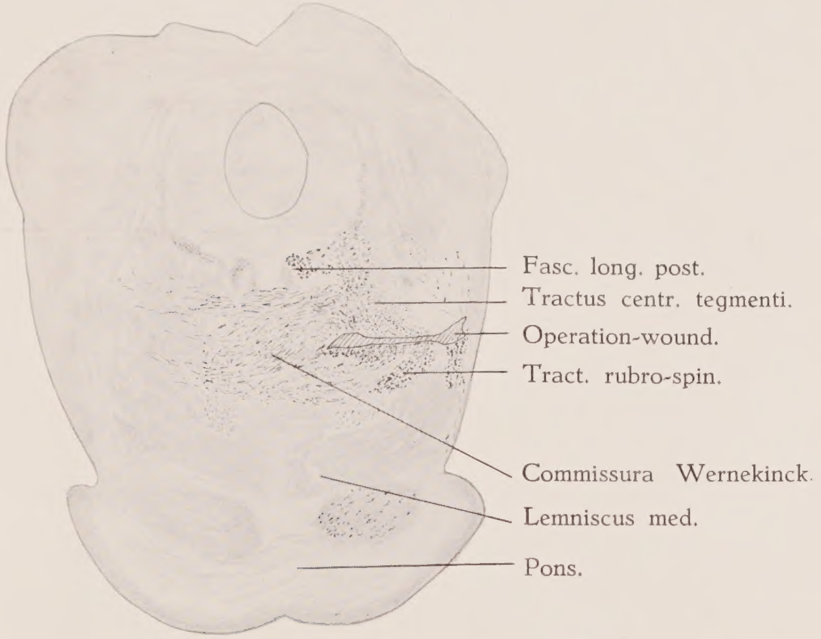


Fig. 2

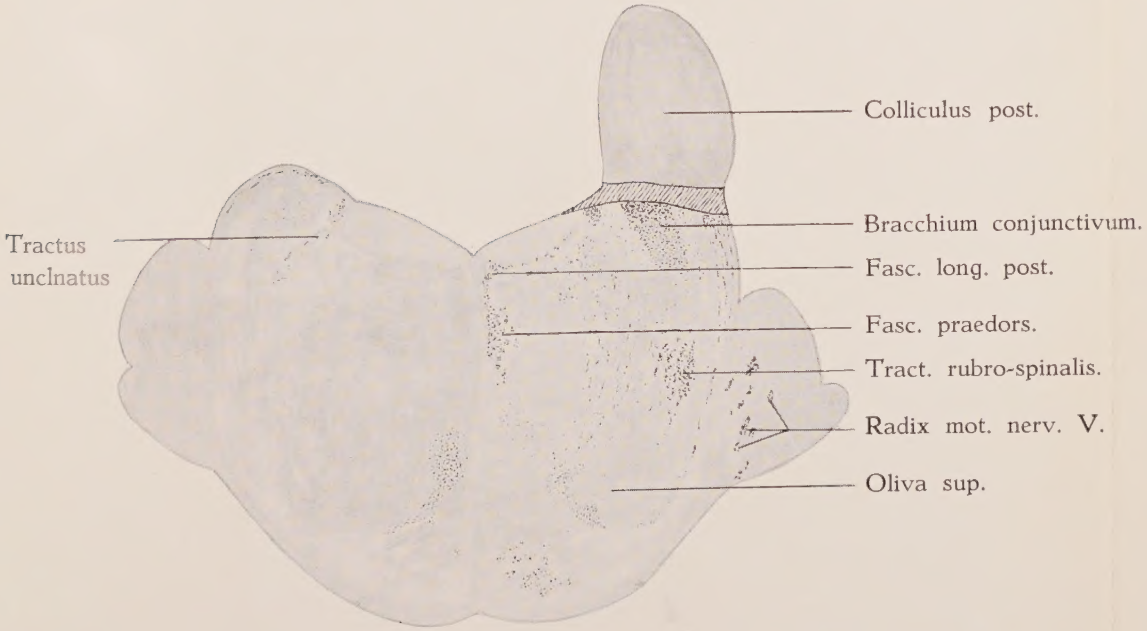


Fig. 3

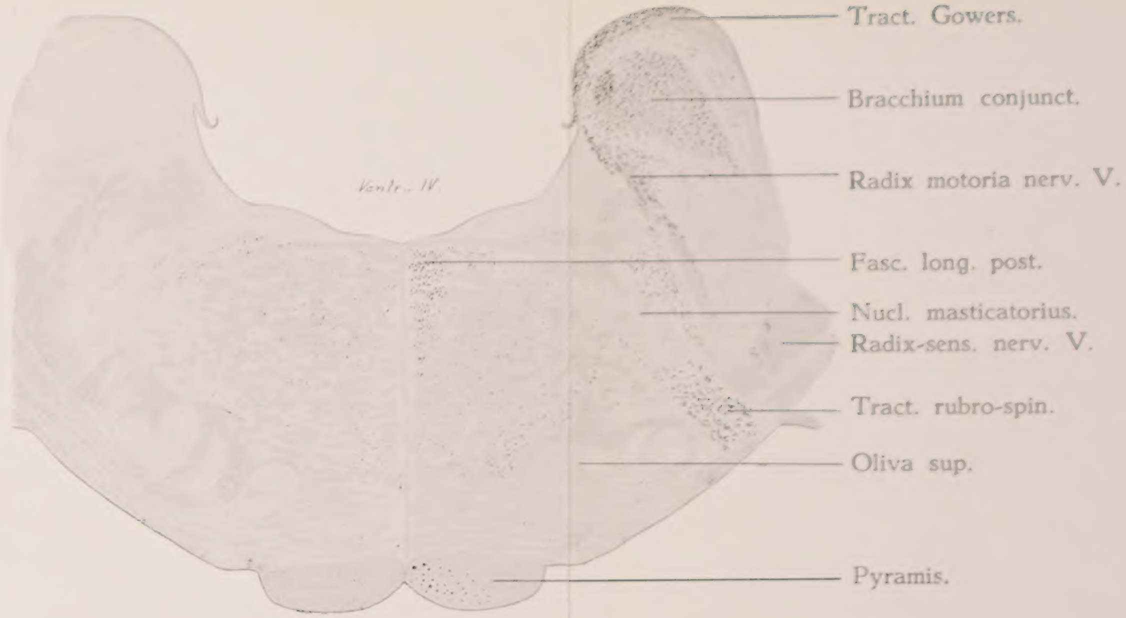


Fig. 4

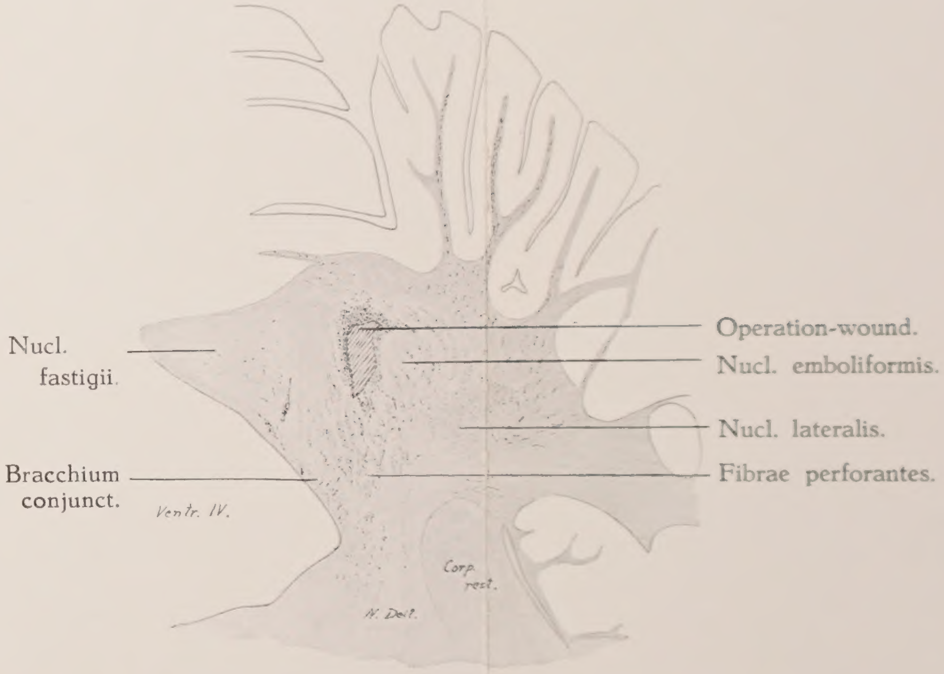


Fig. 5

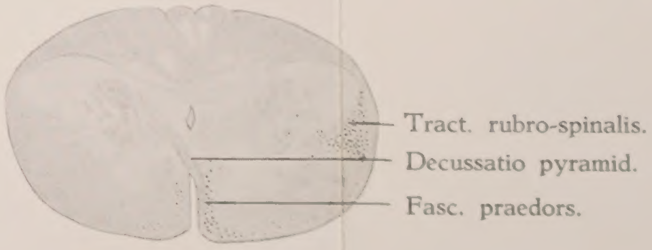


Fig. 6

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the fibrae perforantes degenerated fibres are found, that can be followed to the nucleus DEITERs[1]).

Within its cerebellar course the bracchium conjunctivum contains some MARCHI-grains uniformly distributed over its surface. A few of these degenerated fibres can be traced to the nucleus lateralis, but the rest might be followed to the degenerated fields of the tractus uncinatus and the tractus GOWERs as well as to the destructed area around the nucleus globosus. As the nucleus emboliformis is slightly injured and is one of the nuclei of origin of the bracchium conjunctivum, and the tractus uncinatus as well as the tractus GOWERs according to WINKLER send some fibres into the bracchium conjunctivum, it cannot be decided to what extent the degenerated fibres found in the bracchium conjunctivum between the mesencephalic section and the cerebellum really can be regarded as cerebellopetal fibres.

As was already pointed out, this series was prepared in order to study the problem whether the bracchium conjunctivum cerebelli beside the commonly stated cerebellofugal fibres contains cerebellopetal fibres, or not. In another dog, where the same operation was made but without any lesion in the interior of the cerebellum, there was a distinct degeneration towards the cerebellum. The terminal point of these fibres could not be decided because of the defective penetrating of the osmium around the cerebellar nuclei. However, there was no reason to assume that the degeneration found in the marrow should originate from the bracchium conjunctivum, because a superficial wound in the cerebellar cortex could explain this degeneration.

These two dog's brains together allow the statement that cerebellopetal fibres do occur in small numbers in the bracchium conjunctivum of the dog, but unfortunately they do not distinctly show their terminal point.

In opposition to these findings an examination of five rabbit's brains gave somewhat different results. In these cases too the bracchium conjunctivum was cut through, but only in one case a degeneration could be followed within the cerebellum. This degeneration, however, was very weak and does not contradict the statement that cerebellopetal fibres in the bracchium conjunctivum of the rabbit as a rule do not occur.

The studies are not extensive enough to allow any general conclusions concerning the existence of cerebellopetal fibres in the bracchium

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1) These fibres must represent the axons of PURKINJE-cells, which pass directly to the nucleus DEITERs and which were discovered by LORENTO DE Nó using the method of CAJAL. In the laboratory of Prof. WINKLER I had the opportunity of studying five MARCHI-prepared rabbit's brains, where the cerebellar cortex was injured in the sulcus paramedianus behind the fissura primaria. Degenerated fibres could be found passing from the place of the injury through or between the cerebellar nuclei and among the fibres of the fibrae perforantes reaching the nucleus DEITERs, thus showing a picture corresponding to fig. 5.

conjunctivum of mammals. The difference between the findings in the dog and in the rabbit, however, seems to indicate that their phylogenetical age is rather young.

LITERATURE.

LORENTO DE NÓ: Las conexiones cerebelo-bulbares. Boletin de la Sociedad Espanola de Biologia. Ano X, fasc. IV. 1923.

WINKLER, C.: Opera omnia. Anatomie des centres nerveux.